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# WORK PLAN

## FOR WATERSHED PROTECTION AND FLOOD PREVENTION

# CANBY CREEK WATERSHED

Lincoln and Yellow Medicine County  
Minnesota

Reserve  
aTC425  
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U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE



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WATERSHED WORK PLAN AGREEMENT

Between the

Yellow Medicine Soil and Conservation District  
Local Organization

Lincoln Soil and Water Conservation District  
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Minnesota

and the

Soil Conservation Service  
United States Department of Agriculture

(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Canby Creek Watershed, State of Minnesota, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service, a mutually satisfactory plan for works of improvement for the Canby Creek Watershed, State of Minnesota, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about seven years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the work plan:

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CATALOGING - PREP.



1. Except as hereinafter provided, the Sponsoring Local Organization will acquire, without cost to the Federal Government, such land rights as will be needed in connection with the works of improvement. (Estimated Cost \$300,800). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Land Rights Cost (Dollars)
Multipurpose Structure No. R-1 and Recreational Facilities Payment to Landowners for about 670 Acres	50.8	49.2	186,900
Floodwater Retarding Structures R-4A, R-6, Stream Channel Stabili- zation and Relocation or Modification of Culvert on County Ditch No. 19	100	0	113,900

The Sponsoring Local Organization agrees that all land acquired or improved with Public Law 566 financial assistance or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the operation and maintenance agreement.

2. The Sponsoring Local Organization will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Sponsoring Local Organization will comply with the real property acquisition policies contained in said Act and regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

The Service will bear 100 percent of the first \$25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of \$25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Relocation Payment Cost (Dollars)
Relocation Payments	30	70	12,000

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Multipurpose Structure No. R-1	15	85	668,800
Recreation Facilities	50	50	205,600
Floodwater Retarding Structures R-4A, R-6, Stream Channel Stabili- zation and Grade Stabili- zation Structure	0	100	290,000
Grade Stabilization Structure w/Road	13.8	86.2	14,500

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Engineering Cost (Dollars)
Multipurpose Structure No. R-1, Floodwater Retarding Structures R-4A, R-6, Stream Channel Stabilization and Grade Stabilization Structures	0	100	178,200
Recreation Facilities	50	50	20,600

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$34,300 and \$173,700 respectively.

7. The Sponsoring Local Organization will obtain agreements from the owners of not less than 50 percent of the land above each reservoir and floodwater-retarding structure that they will carry out conservation farm and ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to the landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal, State, and local funds and other assistance to be furnished by the same in carrying out the watershed work plan as this is contingent on the appropriation of Federal and State funds and the raising of local funds as provided under Minnesota law for this purpose.

Where there is a federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

To add a Sponsoring Local Organization to act as a contracting agency for all or part of the project, it will be necessary to execute a supplemental watershed work plan agreement between the new Sponsoring Local Organization and the Service after the new



Sponsoring Local Organization has met the requirements of State law. It will not be necessary to obtain the signature of the other Sponsoring Local Organization, but copies of the signed supplemental work plan agreement will be furnished to them.

14. No member of or delegate to Congress, or resident Commissioner shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the Regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provides that no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

\_\_\_\_\_  
Local Organization

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_ Zip Code \_\_\_\_\_ Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the  
governing body of the \_\_\_\_\_  
Local Organization

adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
Secretary, Local Organization

Address \_\_\_\_\_ Zip Code \_\_\_\_\_

Date \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
Local Organization

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_ Zip Code \_\_\_\_\_ Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the  
governing body of the \_\_\_\_\_  
Local Organization

adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
Secretary, Local Organization

Address \_\_\_\_\_ Zip Code \_\_\_\_\_

Date \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Appropriate and careful consideration has been given to the environmental impact statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service  
United States Department of Agriculture

Approved by:

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State Conservationist

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Date





ADDENDUM

CANBY CREEK WATERSHED

WORK PLAN

Lincoln and Yellow Medicine Counties, Minnesota

August 1974

This addendum was prepared to meet interim requirements of the October 31, 1973, "Principles and Standards for Planning Water and Related Land Resources" of the Water Resources Council.

It includes the following three elements:

1. Benefit-Cost Relationship
2. Abbreviated Environmental Quality Plan
3. Display of Accounts.

BENEFIT-COST RELATIONSHIP

This addendum shows construction costs based on 1974 prices. Costs are amortized for 100 years at 5-7/8 percent interest.

Benefits are based on current normalized prices for agricultural commodities and original values for recreation as set forth in Senate Document 97.

Annual project benefits are \$155,400. Annual project costs are \$133,570.

The benefit-cost ratio is 1.2:1.



## CANBY CREEK WATERSHED

### MINNESOTA

#### ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Improvement in the quality of life can be achieved with water and land resource developments directed at improving the quality of the environment. The objective in formulating this abbreviated plan (EQ Plan) was to emphasize the environmental quality aspects within the Canby Creek Watershed.

#### ENVIRONMENTAL PROBLEMS

Present land use of some areas in and near the flood plain of Canby Creek detracts from the natural beauty of the area. Several homes in Canby built in or near the flood plain have changed the scenery from a natural vegetative state to one of grass lawns and riprapped streambanks. A sand and gravel operation plant uses part of the flood plain for a storage area. Cleanings from their washing operations are pumped into abandoned gravel pits. Junk and other debris are found adjacent to the railroad.

Lake Sylvan's attractiveness has been reduced by sedimentation. The 7 acre lake presently has an average depth of less than 1 foot. During flood stage the lake often extends on to a cemetery inundating several graves. Mud flats appear within the lake during the dry season.

Over-grazing of the flood plain and the adjacent steep banks upstream of Canby has encouraged streambank erosion as well as prevented the reproduction of trees. Severely eroded knolls are visible on the nearby steep cropland. An unsightly barn is located on the streambank of Canby Creek. Existing scenic areas are primarily in private ownership and are not available for public use and enjoyment except for viewing from nearby roads.

Small populations of fish and wildlife exist in most areas of the watershed. Scarce areas of winter cover, nesting cover, brushy areas, and winter food supply limit the populations of pheasant, waterfowl, rabbit, squirrel, and other bird and animal life. Woody cover and browse is limited for white-tailed deer. Fishery waters are confined to Canby Creek between the city and the natural springs. Wildlife habitat on approximately 300 acres of privately owned wetlands would be destroyed any time the owner chooses to drain these areas.

Geological, archeological, and historical resources are known to exist which have a potential for enjoyment by society. These need to be protected and made accessible to the public. Possibilities of additional unknown resources of these types also

exist. They could be damaged or even destroyed unless provisions are made for their identification and protection. They also need to be made accessible for the enjoyment of society.

Water quality in Canby Creek is being reduced primarily from runoff containing sediment and, to a lesser degree, by pesticides and nutrient enrichment from feedlots and fertilizers.

Sedimentation is also reducing the channel capacity below the junction of Lazarus and Canby Creeks and the capacity of the Lac qui Parle Reservoir. Of the total estimated annual yield of 42,000 tons at the mouth of the watershed, 28,000 tons are being deposited in the reservoir.

Approximately three barnyard feedlots are located such that runoff drains directly into Canby Creek reducing water quality.

Upland sheet erosion is occurring on the sloping cropland southwest of Canby. The farming of 8,100 acres with inadequate land treatment is causing erosion amounting to an average of 13 tons per acre per year. Limited sheet erosion is also occurring on the sloping pasture land southwest of Canby. Erosion on this land is estimated to be less than 4 tons per acre per year.

Streambank erosion is occurring intermittently on 14 miles of Canby Creek channels upstream from the city of Canby. This erosion is occurring at a rate of 100 tons per channel mile on an annual basis. The land voided by streambank erosion is approximately 0.01 acre per year per mile of channel.

Streambank and channel bottom erosion is also occurring on about 500 feet of previously modified channel of Canby Creek within Canby. The channel banks and bottom consist of a fine sand and gravel mixture. At present, erosion is occurring in various areas along this reach, particularly on areas with a small amount of vegetation.

The desired movement of bedload materials from the lower 2,000 feet of Canby Creek, upstream of St. Leo Road, will be upset anytime the landowner chooses to sell the gravel mineral rights of the immediate area. The movement of bedload materials in and below the watershed is presently stabilizing the channel bottom. Without the movement of these materials, channel stabilization would cease and severe erosion would commence.

Roadside erosion is causing damage to the roadsides and road ditches as well as contributing to the downstream sedimentation problems. Total area of erosion approximates 5 acres. Some gully erosion is occurring on steeper areas throughout the watershed. The land voided from gully erosion is estimated at 0.3 acre per year. The average amount of sediment from gully erosion is estimated at 0.3 ton per acre per year on 9,600 acres.



Air pollution may be occurring from the electrical power plant and other manufacturing firms.

#### COMPONENT NEEDS

Component needs include the following:

1. Restore the flood plain to a natural vegetative condition.
2. Establish public areas of open and green space including a school outdoor laboratory.
3. Establish, improve, and manage fish and wildlife habitat areas.
4. Protect and make accessible geological, archeological, and historical resources with a potential for human enjoyment. Identify possible unknown resources and treat in a like manner.
5. Develop a water quality monitoring program of Canby Creek. Investigate smoke emission features of local manufacturing firms and correct any existing deficiencies.
6. Improve water, land, and air quality by controlling erosion, sedimentation, and other pollutants.
7. Implement a comprehensive land and water use plan.

#### ELEMENTS OF ENVIRONMENTAL QUALITY PLAN

The environmental quality plan includes the following elements:

1. Restore natural conditions of grassland, rangeland, and forest land along the stream and the adjacent steep banks for a distance of approximately 8 miles from the outlet of the watershed through Canby and upstream to and including the north-east corner of section 22, T. 114 N., R. 46 W. This area of approximately 1,200 acres will be purchased, fenced, and managed in the public's interest. Existing cropland would be converted to grassland and trees. Grazing would be eliminated or allowed only on areas where necessary to manage for successional vegetation stages capable of improving fish and wildlife habitat and human enjoyment. Relocation would involve 3 families within Canby and 3 farm families. Their homes and farm buildings would be relocated or destroyed and the area they occupied converted to a natural condition. The storage area used by the sand and gravel operation would be relocated away from the stream. The operation itself would be screened with trees and shrubs. Junk and debris would be removed. Ten graves would be relocated to higher elevations within the cemetery.

Accesses, parking areas, picnic tables, and sanitary facilities will be developed to provide additional enjoyment of the area for people. Annual operation and maintenance including caretaker services will be provided.

About 18 acres of sand and gravel rights will be obtained along Canby Creek. This area will be retained in its natural state to insure a continuing supply of stabilizing gravels to county ditch No. 8 below the project area for the life of the project. Estimated installation cost is \$700,000. Annual operation, replacement, and maintenance cost is \$10,000.

2. Establish and/or improve 5 farmstead windbreaks approximating 10 acres at an estimated cost of \$2,000.

3. Convert 3,400 acres of cropland containing large areas with severe and very severe limitation for crop production to approximately 3,000 acres of pastureland and 400 acres of forest land. Estimated cost is \$250,000 including \$60,000 for land rights and \$190,000 for seeding and planting.

4. Landscape trails, nature areas, and parks in Canby and along two miles of Highway 68 and 75 by establishment of plants and shrubs possessing natural beauty at an estimated cost of \$20,000.

5. Replace the outlet structure of Lake Sylvan with a grade stabilization structure. Include features of a lower spillway elevation to drain the lake. Shape and establish cover plantings on the drained lake area and restore the stream to a more natural condition. Estimated cost is \$12,000.

6. Develop a school outdoor laboratory located adjacent to the natural area along the stream. Estimated cost is \$6,000.

7. Establish 200 acres of woody wildlife upland habitat in scattered one to five acre plots throughout the watershed. Expect needed land to involve 100 acres of cropland and 100 acres of pasture. Estimated cost is \$60,000 including \$50,000 for land rights and \$10,000 for seeding and planting.

8. Restore 200 acres of wildlife wetland habitat and assure preservation of the existing 300 acres of wetlands by transferring land to public ownership. Estimated cost is \$145,000 including \$135,000 for land rights and \$10,000 for seeding and developing.

9. Improve 5 miles of stream for trout habitat at an estimated cost of \$25,000.

10. Provide winter food plots for wildlife. An average of one-half acre of standing crops per farm on 95 farms will be left unharvested until spring. Estimated cost is \$45,000 for land rights.

11. Properly manage the forest land, grassland, wetlands, and 5 miles of Canby Creek for fish and wildlife habitat at an annual cost of \$10,000.

12. Protect and make accessible to the public geological, archeological, and historical resources with a potential for enjoyment. Establish a market along U.S. Highway 75 containing a description of the geological features of the Coteau des Prairies and the steep slope along the edge of the Coteau. Evaluate archeological site in section 34, T. 114 N., R. 46 W. (21-Y.M.-27), and if valuable protect and make accessible to the public. Estimated cost \$3,000.



13. Arrange for professionals to investigate and evaluate the watershed area for additional geological, archeological, and historical resources. Likewise, protect and make accessible to the public those resources with a potential for enjoyment. Estimated cost \$5,000.

14. Apply needed conservation land treatment practices on 4,500 acres of cropland and 4,000 acres of pasture presently subject to erosion damage and which will not be converted to other land uses. Accelerate the application of such practices as conservation cropping system, minimum tillage, crop residue management, terraces, and grasses waterways. Conduct water quality surveys of Canby Creek to determine the extent and location of possible polluttional discharges. Estimated cost is \$245,000 including \$200,000 for application and \$45,000 for technical assistance.

15. Install 15 holding ponds or tanks for containing runoff from barnyards at a cost of \$50,000.

16. Apply erosion control practices on areas of roadside erosion amounting to approximately 5 acres at 20 locations for a cost of \$20,000.

17. Adopt improved application techniques in the use of fertilizer and pesticides.

18. Investigate smoke emission features of local manufacturing firms and, if needed, incorporate approved smoke emission features in them.

19. Implement a comprehensive land and water use plan including environmental values for Yellow Medicine and Lincoln Counties. Include flood plain management regulations for the remaining privately owned flood plain land along Canby Creek. Estimated cost is \$10,000.

A capital investment of about \$1,600,000 and an annual operation, maintenance, and management cost of about \$20,000 will be required for the installation of the Environmental Quality Plan. About 50 man-years of labor will also be required.

#### INSTITUTIONAL ARRANGEMENTS AVAILABLE AND NEEDED FOR THE IMPLEMENTATION OF THE ABBREVIATED ENVIRONMENTAL QUALITY PLAN (EQ PLAN)

Legal entities of government are in existence for the implementation of the EQ Plan. They include township and county government, joint powers of county government and soil and water conservation districts, or Lac qui Parle-Yellow Bank Watershed District. All of these have the power of eminent domain and taxation by law.

Several private, state, and federal programs are available providing financial assistance both for land acquisition and for establishment of measures to implement the EQ Plan, namely:

### Private Programs

1. Minnesota Chapter of Nature Conservancy - Acquires and manages land of high ecological value.

### State Programs

1. Minnesota Department of Natural Resources
  - a. Forestation Program - Provide tree planting stock and technical assistance.
  - b. Private Land Wildlife Habitat Improvement Program - Provide financial and technical assistance to create wildlife habitat on private lands.
  - c. Wetlands Acquisition Program - Acquire and maintain wetland areas.
  - d. Natural Resources Funds - Provide financial assistance for developing fish and wildlife habitat and recreational areas.
2. State Planning Agency (Division of Parks and Recreation) - Land acquisition and development of recreational facilities.

### Federal Programs

1. U.S. Department of Agriculture
  - a. Resource Conservation and Development - Financial and technical assistance involving human and natural resources.
  - b. Water Bank Act - Provides compensation to landowners for maintaining wetlands.
  - c. Rural Environmental Conservation Program - Provides cost-sharing assistance to individual landowners for application of conservation practices.
  - d. Loans and Advances - Provides loans and advances to sponsoring organizations.
2. U.S. Department of the Interior
  - a. LAWCON Funds - Provides financial assistance for developing fish and wildlife habitat areas. Administered by the state.
  - b. Pitman-Robertson Funds - Provides for wildlife research and financial and technical assistance in developing wildlife habitat areas. Administered by the state.
  - c. Dingell-Johnson Funds - Provides for fishery research and financial and technical assistance in developing fishery habitat areas. Administered by the state.
  - d. Small Wetlands Acquisition Program - Acquire and maintain wetland areas.

Technical assistance including educational and on-site assistance is available from:

1. Local Soil and Water Conservation Districts
2. Agricultural Extension Service
3. Minnesota Department of Natural Resources



4. USDA including Soil Conservation Service and Forest Service
5. USDI, Fish and Wildlife Service.

In spite of the many available programs to financial assistance, higher priorities for the funds exist in other areas of the state and nation. Therefore, additional sources of funds are needed to assist the local entity of government to implement the EQ Plan.

Lincoln and Yellow Medicine Counties need to adopt a land use policy and provide for the enforcement of the policy.

#### ENVIRONMENTAL EFFECTS OF THE ENVIRONMENTAL QUALITY PLAN

The implementation of the EQ Plan for Canby Creek Watershed will provide environmental benefits for present enjoyment as well as for future generations.

Areas of natural beauty and human enjoyment will be increased with the establishment of the 1,200 acre nature area along Canby Creek, farmstead windbreaks and forests; landscaping in Canby along the major highways; improvements of Lake Sylvan area; and development of a school outdoor laboratory.

The biological resources will increase in quantity and quality with the establishment of additional habitat areas for fish and wildlife. This will be achieved by the establishment and management of added areas of trout stream habitat, woody and herbaceous cover, forest land, wetlands, grasslands, food plots, as well as improved crop residue management on the cropland.

The known geological, archeological, and historical resources will be protected and made accessible for the benefit of society. Unknown resources will be located and treated in like manner.

The application of conservation land treatment practices, conversion of certain cropland areas to pasture, installation of barnyard holding ponds or tanks, and improved application techniques in the use of fertilizer and pesticides will reduce nutrient enrichment of the runoff entering Canby Creek. Total annual sediment yield at the outlet of the watershed will be reduced from 42,000 to 13,000 tons per year. Wind and water erosion will be controlled on 8,200 acres of cropland presently possessing erosion problems and on 5 acres of roadside areas.

The stream channel stabilization and maintenance of natural conditions on the lower 2,000 feet of Canby Creek will continue to provide stable channel conditions in the lower part of the watershed and protect the desirable movement of bedload materials to the channel below the watershed.

Land use patterns will adjust slightly with an increase of land in pasture, forest, and other uses primarily in recreation, fish and wildlife, and a decrease of land in cropland. See table below.

Land Use Patterns with EQ Plan

Canby Creek Watershed						
Item	Cropland	Pasture	Forest	Urban	Other	Total
Present Land Use	12,400	5,050	110	330	2,260	20,150
Land Use Conversion	-3,900	+1,900	+400	-	+1,600 <sup>1/</sup>	-
Land Use With EQ Plan	8,500	6,950	510	330	3,860	20,150

<sup>1/</sup> Land converted to recreation, fish, and wildlife areas.

Adoption of county wide land use policy including the flood plain management regulations will identify and protect other environmentally sensitive areas. Guidance would be given to residential, industrial, and agricultural developments so that other environmental conflicts are recognized and properly resolved.

#### DISPLAY OF ACCOUNTS

The following system of accounts illustrates a display of beneficial and adverse effects of the selected plan for Canby Creek Watershed on the components of National Economic Development and Environmental Quality Objectives and on the Regional Development and Social Well-Being Accounts. This is consistent with the Water Resource Council's adopted Principles and Standards.

SELECTED PLAN  
CANBY CREEK WATERSHED, MINNESOTA  
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

COMPONENTS Beneficial Effects	MEASURES OF EFFECTS (Avg. Annual Dollars) <sup>1/</sup>	COMPONENTS Adverse Effects	MEASURES OF EFFECTS (Avg. Annual Dollars) <sup>1/</sup>
A. The value to users of increased outputs of goods and services		A. The value of resources required for a plan	
1. Flood Prevention	59,420	1. Two floodwater retarding structures,	
2. Recreation	71,700	1 multi-purpose structure, recreation facilities, and stream channel stabilization	
		Project installation	91,250
		(structural measures)	11,240
		Project administration	21,070
		OM&R	<u>123,560</u>
Total beneficial effects	<u>131,120</u>	Total adverse effects	7,560
		Net beneficial effects	

<sup>1/</sup> Amortized for 100 years at 5-3/8 percent interest.



SELECTED PLAN  
CANBY CREEK WATERSHED, MINNESOTA  
ENVIRONMENTAL QUALITY ACCOUNT

COMPONENTS		MEASURES OF EFFECTS
Beneficial and adverse effects:		
A. Areas of natural beauty	1.	Create a 147 acre lake in site R-1 inundating 46 acres cropland, 63 acres pasture, 34 acres woods, and 4 acres miscellaneous areas.
	2.	Create a 13 acre type V wetland inundating 13 of pasture.
	3.	Add to the aesthetics of the area with the application of certain land treatment practices such as tree planting, farm ponds, and wildlife wetland habitat management.
	4.	Remove 84 acres of streamside wooded areas and 3 miles of stream.
	5.	Increased traffic in the recreational area accompanied by the usual noise, solid waste, and air pollution from 47,800 recreational visits annually.
B. Biological resources and ecosystems	1.	Create a 147 acre lake capable of supporting warm water fishery and a 13 acre type V wetland providing wildlife habitat.
	2.	Change habitat on 147 acres from terrestrial to aquatic type.
	3.	Permanently inundate one and one-half mile of trout stream.
	4.	Wildlife and game habitat will be improved by certain land treatment practices such as tree planting, farm-ponds, and wildlife wetland habitat management.
	5.	Existing vegetation will be destroyed on the proposed structure sites disrupting upland game and other wildlife habitat until new vegetation is established. Some wildlife will be destroyed by construction equipment.

MEASURES OF EFFECTS

COMPONENTS

Beneficial and Adverse Effects:

C. Quality consideration of water, land, and air resources

1. Reduce erosion on 7,500 acres of cropland and pasture-land.
2. Reduce sediment delivered to the Lac qui Parle Reservoir by 23,600 tons per year.
3. Reduce average land voided by gully erosion from 0.3 to 0.1 acre per year.
4. Increase sediment during construction.
5. Protect land located at the lower end of the watershed to minimize erosion in county ditch No. 8 by assuring continuation of desired movement of bedload materials into the ditch.

D. Irreversible or irretrievable commitments of resources

1. Conversion of 545 acres of cropland, 384 acres of pastureland, 84 acres of woods and brushland, and 50 acres in miscellaneous uses to the structural measures.
2. About 4.5 miles of stream will be committed to the structural measures.

SELECTED PLAN  
CANBY CREEK WATERSHED, MINNESOTA  
REGIONAL DEVELOPMENT ACCOUNT

COMPONENTS		MEASURES OF EFFECTS (Avg. Annual Dollars) <sup>1/</sup>		COMPONENTS		MEASURES OF EFFECTS (Avg. Annual Dollars) <sup>1/</sup>	
		State of Minnesota	Rest of Nation			State of Minnesota	Rest of Nation
A.	Income:			A.	Income:		
	Beneficial effects:				Adverse effects:		
1.	The value of increased outputs and services to users residing in the region.			1.	The value of resources contributed from within the region to achieve the outputs.		
a.	Flood prevention	59,420	-	a.	Two floodwater retarding structures, a multipurpose structure, recreation facilities and stream channel stabilization.		
b.	Recreation	71,700	-		Project installation (structural measures)	23,020	68,230
c.	Secondary	15,380	-		Project administration	1,850	9,390
					OM&R	21,070	-
	Total beneficial effects	146,500	-		Total adverse effects	45,940	77,620
					Net beneficial effects	100,560	-77,620

<sup>1/</sup> Amortized for 100 years at 5-3/8 percent interest.



COMPONENTS		MEASURES OF EFFECTS		COMPONENTS	MEASURES OF EFFECTS	
		State of Minnesota	Rest of Nation		State of Minnesota	Rest of Nation
C.	Population distribution:			C.	Population distribution:	
	Beneficial effects:	<p>Creates 1.5 semi-skilled part-time jobs for 3 months, 1 semi-skilled permanent job, 70 skilled jobs and 30 semi-skilled jobs for 1 year primarily in an isolated rural area which has experienced a 6.5 percent reduction in population between 1960 and 1970.</p>				
			-		Adverse effects:	-
					Two farm families will need to relocate.	



COMPONENTS		MEASURES OF EFFECTS		COMPONENTS	MEASURES OF EFFECTS	
		State of Minnesota	Rest of Nation		State of Minnesota	Rest of Nation
D.	Regional Economic Base and Stability:			D.	Regional Economic Base and Stability:	
	Beneficial effects:	Provides flood protection to a 470 acre rural and urban flood plain within the watershed and to a 4,730 acre rural flood plain downstream of the watershed. Provides recreational facilities with a permanent lake area of 147 acres. Creates 1 permanent semi-skilled job and 70 short term skilled and 31.5 short term semi-skilled jobs in an area where 23 percent of the families have incomes of \$4,000 or less.	-		Adverse effects:	-
					Reduce tax base for township and county governments by 615 acres.	

SELECTED PLAN  
CANBY CREEK WATERSHED, MINNESOTA  
SOCIAL WELL-BEING ACCOUNT

COMPONENTS		MEASURES OF EFFECTS		
Beneficial and adverse effects:				
A.	Real income distribution	1. Create 1 permanent and 31.5 part-time low to medium income jobs for area residents.		
		2. Create regional income benefit distribution of \$146,500 annually by income class as follows:		
			Percentage of	Percentage of
			Families in	Benefits to
			Each Income	Accrue to
		Income Class	Class	Class
		(Dollars)		
		Less than 4,000	23	10
		4,000 - 12,000	61	55
		More than 12,000	16	35
		3. Local costs to be borne annually by region of \$45,940 with distribution by income class as follows:		
			Percentage of	Percentage of
			Families in	Contributors
			Each Income	in
		Income Class	Class	Class
		(Dollars)		
		Less than 4,000	23	10
		4,000 - 12,000	61	55
		More than 12,000	16	35
B.	Life, health, and safety	1. Provide one percent level of flood protection in urban area.		
		2. Relocation of two farm families.		
C.	Recreation opportunities	1. Creates recreational activities amounting to 47,800 annual visits for a rural population including a city of 2,147.		



WATERSHED WORK PLAN

CANBY CREEK WATERSHED

Yellow Medicine and Lincoln Counties, Minnesota

Prepared Under the Authority of the Watershed  
Protection and Flood Prevention Act, (Public  
Law 566, 83d Congress, 68 Stat. 666), as amended.

Prepared by:

Yellow Medicine Soil and Water Conservation District  
Lincoln Soil and Water Conservation District

With assistance by:

U.S. Department of Agriculture, Soil Conservation Service  
U.S. Department of Agriculture, Forest Service  
U.S. Department of Interior, Fish and Wildlife Service  
Minnesota Department of Natural Resources

July 1974





# Table of Contents

Item	Page
SUMMARY OF PLAN - - - - -	1
DESCRIPTION OF THE WATERSHED - - - - -	3
Physical Data - - - - -	3
Economic Data - - - - -	4
Land Treatment Data - - - - -	6
Fish and Wildlife Resource Data - - - - -	6
WATERSHED PROBLEMS - - - - -	7
Floodwater Damage - - - - -	7
Soil Erosion and Sedimentation - - - - -	8
Problems Relating to Water Management - - - - -	8
Drainage - - - - -	8
Irrigation - - - - -	9
Municipal and Industrial Water - - - - -	9
Recreation - - - - -	9
Fish and Wildlife - - - - -	9
PROJECTS OF OTHER AGENCIES - - - - -	10
PROJECT FORMULATION - - - - -	10
WORKS OF IMPROVEMENT TO BE INSTALLED - - - - -	14
Land Treatment Measures - - - - -	14
Structural Measures - - - - -	15
General - - - - -	15
Single-Purpose Flood Prevention Structures - - - - -	16
Multiple-Purpose Structure - - - - -	18
Recreation Facilities - - - - -	19
Stream Channel Stabilization on Canby Creek - - - - -	19
Nonstructural Measures - - - - -	20
Natural Stream Conditions on Canby Creek - - - - -	20
Cultural Assessment - - - - -	20
Water Quality Monitoring - - - - -	20
EXPLANATION OF INSTALLATION COSTS - - - - -	21
Land Treatment - - - - -	21
Structural Measures - - - - -	21
EFFECTS OF WORKS OF IMPROVEMENT - - - - -	26
Land Treatment Measures - - - - -	26
Structural Measures - - - - -	26
PROJECT BENEFITS - - - - -	29
COMPARISON OF BENEFITS AND COSTS - - - - -	30
PROJECT INSTALLATION - - - - -	30
FINANCING PROJECT INSTALLATION - - - - -	32
PROVISIONS FOR OPERATIONS AND MAINTENANCE - - - - -	34
TABLE 1 - ESTIMATED PROJECT INSTALLATION COST - - - - -	36
TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT - - - - -	38
TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION - - - - -	39
TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY - - - - -	40
TABLE 2B - RECREATION FACILITIES - ESTIMATED CONSTRUCTION COST - - - - -	41
TABLE 3 - STRUCTURE DATA - - - - -	43
TABLE 3A - STRUCTURE DATA - CHANNELS - - - - -	46

# Table of Contents (Continued)

Item	Page
TABLE 3B - STRUCTURE DATA - GRADE STABILIZATION STRUCTURES	47
TABLE 4 - ANNUAL COST - - - - -	48
TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS - - - - -	49
TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES - - - - -	50
TABLE 7 - CONSTRUCTION UNITS - - - - -	51
INVESTIGATION AND ANALYSES - - - - -	52
Hydraulic and Hydrologic Investigations - - - - -	52
Hydraulic Studies - - - - -	52
Hydrologic Studies - - - - -	52
Multiple-Purpose and Floodwater Retarding Structure Design Hydrologic Criteria - - - - -	54
Stream Channel Stabilization Design Hydrologic Criteria - - - - -	55
Land Use Treatment - - - - -	55
Economics - - - - -	56
Floodwater Damage Reduction - - - - -	56
Indirect Damages - - - - -	57
Land Enhancement Benefits - - - - -	57
Recreational Benefits - - - - -	57
Secondary Benefits - - - - -	58
Price Base for Benefits and Costs - - - - -	58
Basis of Cost Allocation to Purpose - - - - -	58
Geologic Investigations - General - - - - -	59
Geologic Investigations - Site R-1 - - - - -	59
Range of Permissible Data Extrapolation - - - - -	59
Effect of Site on Groundwater Table - - - - -	59
Recreation Facilities - - - - -	60
Structure Sediment Storage Requirements - - - - -	60
Channel Stability Investigations - - - - -	60
Engineering - - - - -	61
Canby Creek Subwatershed - - - - -	61
County Ditch No. 19 Subwatershed - - - - -	63
Miller Group Subwatershed - - - - -	64
EXHIBIT 1 - - - - -	66
EXHIBIT 2 - - - - -	67
EXHIBIT 3 - - - - -	68
EXHIBIT 4 - - - - -	69
URBAN FLOOD PLAIN MAP	
WATER DEVELOPMENT PROJECT MAP	
R-1 RECREATION MAP	
PROJECT MAP	

## WATERSHED WORK PLAN

### CANBY CREEK WATERSHED

Yellow Medicine and Lincoln Counties, Minnesota

July 1974

#### SUMMARY OF PLAN

The major portion of the Canby Creek Watershed is located in western Yellow Medicine County in west central Minnesota with small portions of the watershed in Lincoln County, Minnesota. The watershed has a drainage area of 32 square miles or 20,150 acres and is a tributary of the Minnesota River Basin.

The area studied for the plan consists of two sub-watersheds known as Canby Creek, and county ditch No. 19. These two watersheds have separate outlets during normal flow.

Canby Creek is the major stream system in the watershed. County ditch No. 19 is included in the plan because of its common flood plain with Canby Creek during flood stage.

The two sub-watersheds are hereafter known as the Canby Creek Watershed in this plan.

The Canby Creek Watershed work plan was prepared by the Yellow Medicine and Lincoln County Soil and Water Conservation Districts as the Sponsoring Local Organization. Technical assistance was provided by the Soil Conservation Service, the Forest Service of the U.S. Department of Agriculture, the Fish and Wildlife Service of the U.S. Department of the Interior, and the Minnesota Department of Natural Resources.

Floodwaters cause damages to crops, pastures, city of Canby, roads, and bridges. Most of the floodwater damages are downstream from Highway No. 68. Approximately 145 residential and business establishments within Canby and 470 acres of land have a floodwater problem. An additional 4,730 acres located downstream of Canby Creek Watershed also have a floodwater problem. These problems are the result of inadequate channel capacities, causing the floodwater to overflow the banks and across much farm land before returning to the channel. The Sponsoring Local Organization is interested in providing adequate flood protection, controlling wind and water erosion, and developing a water-based recreation area.



Implementation of this plan will alleviate the majority of the floodwater problems in this watershed with the installation of the following measures: One multiple-purpose floodwater-retarding-recreation structure on Canby Creek, two floodwater-retarding structures which includes one in the upper reaches of Canby Creek and the other above county ditch No. 19, and approximately 4,200 feet of stream channel stabilization involving two grade stabilization structures. The natural stream conditions will be maintained immediately below the stream channel stabilization on Canby Creek for the protection of bedload movement and aesthetic and wildlife values.

A recreational development is planned on 275 acres adjacent to a 147 acres permanent pool on the multipurpose floodwater-retarding-recreation structure. Facilities will include picnic area, camping area, boat launch, fishing access, swimming facilities, and hiking trails. The facilities are designed to accommodate 47,800 visitor days annually.

The measures will be installed and maintained under the supervision of the Lac qui Parle-Yellow Bank Watershed District. The Watershed District will be responsible for signing a supplemental watershed work plan agreement and the project agreement after the legal requirements under Minnesota State law have been fulfilled.

Land treatment measures which have significance in reducing floodwater damages and controlling wind and water erosion and resulting sedimentation will continue to be applied. Public Law 566 will provide additional funds for technical assistance to accelerate this phase. These measures will be installed and maintained by cooperators of the Soil and Water Conservation Districts with technical assistance from the Soil Conservation Service and the Minnesota Department of Natural Resources, Division of Lands and Forestry, in cooperation with the U.S. Forest Service.

It is estimated that the local people have spent \$76,260 to date for application of land treatment measures. During the project installation period, an additional sum of \$209,100 will be spent.

The total installation cost of the planned structural measures is estimated at \$1,896,500. The Public Law 566 cost is \$1,436,300, and the other cost is \$460,200. The project installation period is 7 years.

These structural measures will reduce floodwater damages to crop and pasture, road and bridge, urban, and other agricultural damages within the watershed by 90 percent, and will provide a water-based recreation development near Canby. An additional 5 percent reduction of damages was claimed for the proposed land treatment measures.

Responsibility for the operation and maintenance agreements will be borne by the Watershed District, Lincoln and Yellow Medicine Soil and Water Conservation Districts, at an estimated annual cost of \$21,070. The Soil Conservation Service will provide technical assistance and assist with the maintenance inspections during the first 3 years.

The benefit-cost ratio for the project is 1.2:1.

#### DESCRIPTION OF THE WATERSHED

##### Physical Data

Canby Creek Watershed is located mainly in Yellow Medicine County in west-central Minnesota. It includes an area of 20,150 acres or 32 square miles. There are 1,820 acres of the watershed in Lincoln County, and 18,330 acres in Yellow Medicine County.

The watershed presently has two separate outlets during periods of normal flow. The major tributary, Canby Creek, with a drainage area of 26.8 square miles, outlets into county ditch No. 8 at the St. Leo Road. County ditch No. 19, with a drainage area of 4.7 square miles, outlets into Lazarus Creek, 1.5 miles north of Canby.

Canby Creek originates in the southwest corner of Yellow Medicine County; flows northeast through the city of Canby, Minnesota, and outlets into county ditch No. 8. This legal ditch in turn outlets into Lazarus Creek. From this point, the creek flows north and then east into the Lac qui Parle River. The Lac qui Parle River flows into the Minnesota River at the south end of the Lac qui Parle Reservoir approximately 10 miles northwest of Montevideo, Minnesota.

Canby Creek Watershed is approximately 2.5 miles wide and 12 miles long. The maximum elevation in the watershed is 1,785 feet and the minimum is 1,188 feet above mean sea level. The maximum fall of Canby Creek is 68 feet per mile and the minimum is 15 feet per mile.

The upper third of the watershed is gently rolling to undulating plateau containing several small marsh areas. Fine textured prairie soils derived from glacial till occur in the area. Sheet erosion occurs on the steeper cultivated land.

The lower two thirds of the watershed (above the city of Canby) contains rolling, steep, hilly land with short slopes and numerous knolls. Canby Creek is well entrenched and has a steep gradient through this reach. Some springs and seeps occur. Soils predominate the area, but small sandy and gravelly areas are common. Sheet erosion is occurring on the cultivated land.



A small portion of the watershed, in the vicinity of Canby, consists of a sloping glacial lake plain. Canby Creek has cut a narrow, moderately entrenched, flood plain through the glacial lake plain deposits in the vicinity of Canby. Silty moderately well drained to imperfectly drained soils are predominate in the area. Fine soils as well as sandy soils and soil underlain by gravel occur in the area.

The area immediately below the outlet of the proposed watershed is a glacial lake plain sloping to the north. Canby Creek has no defined flood plain through this reach. The area is drained by county ditch No. 8, a legal ditch which was reconstructed in 1955.

A larger area of glacial lake plain is located about 9 miles downstream of the Canby Creek Watershed. Both Canby Creek and Lazarus Creek drain through this area. The channel through the glacial lake plain is a natural winding drainage way of limited capacity which creates frequent flooding.

A monthly normal temperature in the Canby Creek Watershed ranges from 74 degrees F. in July to 13 degrees F. in January. The extreme temperatures recorded in the city of Canby during 40 years of record are 111 degrees F. above to 33 degrees F. below zero. The average date of the last frost is May 10, and that of the first frost is October 2, an average frost-free period of 145 days.

The mean annual precipitation, including snowfall, is 24 inches with approximately 75 percent occurring during the growing season from April through September. The mean annual snowfall is 41 inches.

#### Economic Data

The major farm enterprises of the approximately 95 farm operators which have all or part of their farms within the watershed are beef, hogs, and cash grain crops. Slightly over half of the total value of farm products sold is in the form of livestock and livestock products. The average gross income per farm in Yellow Medicine County in 1964 for all farm products sold was \$13,219, while in 1959 the average income was \$9,250 (U.S. Agricultural Census Data).

In 1964, full-time farm operations selling farm products valued at less than \$5,000 accounted for 17½ percent of the total farm operators in Yellow Medicine County. Seven and one-half percent of the farm operators sold farm products values at less than \$2,500.

Approximately 62 percent of the watershed is in cropland producing mainly corn, soybeans, small grain, and hay. About 25 percent is in pastureland while the remaining land is forest land, and other land such as areas managed for wildlife, farmsteads,

roads, and urban areas. Average crop yields per acre on the flood plain are as follows: corn - 65 bushels, soy beans - 22 bushels, oats - 60 bushels, and hay - 3.35 tons. The average farm is about 220 acres in size and has an average value of \$175 to 200 per acre. Land with a flooding problem has an average value of \$150 to 200 per acre. All the land is in private ownership except 370 acres of wildlife land owned by the State. In Yellow Medicine and Lincoln Counties, about 30 percent of all farms are operated by tenants.

Approximately 110 acres of the watershed are in forest cover which occurs along drainages and on irregular slopes. Present forest type is northern hardwood consisting mainly of bur oak. There are no markets for local forest products within the economic area of the watershed. All forest land is privately owned. Adequate forest fire protection is provided by local fire departments. No fires have been recorded during the past 5 years. Current Federal-State forestry programs available to forest landowners include Cooperative Forest Management, Cooperative Forestation, and Cooperative Insect and Disease Control.

The population of the watershed is approximately 1,400 people, of which about 1,075 live in the city of Canby. Businessmen, residents, and farm operators located within the flood plain frequently suffer damages from flooding which generally causes the greatest economic difficulty.

Sixty-three percent of the 2,751 registrants with the Minnesota Department of Employment Security earned less than \$3,000 a year according to their survey conducted in Yellow Medicine County during 1965 and 1966. This group, which included students and housewives, is about 12 percent of the population of Yellow Medicine County. About 30 percent of the registrants lived in the Canby area while 20 percent listed agriculture as their occupational field.

The watershed is well served by federal, state, county, and township roads. The Chicago and Northwestern Railroad runs through Canby and the lower part of the watershed.

Canby is an active community serving a rural retail trade area of about 725 square miles. The annual retail sales in Canby in 1962 was estimated to be 3.5 million dollars. The 1962 real estate full assessed valuation was slightly over \$3,100,000. The per capita debt is below average. The population has been maintained during the last 40 years, whereas many other towns in western Minnesota have decreased in population. The area for expansion within Canby is limited. The city officials have expressed that the ideal location is toward the east in the area now subject to frequent flooding. A vocational-technical school was recently established to provide an educational opportunity for the youth in the area.



### Land Treatment Data

The Lincoln and Yellow Medicine Soil and Water Conservation Districts have followed an intensive program of planning and applying needed land treatment measures. At the time of work plan preparation, there are 55 cooperators with the districts covering about 54 percent of the area of the watershed. Of this amount, 20 have developed soil and water conservation farm plans covering about 20 percent of the watershed.

Approximately 4,170 acres of cropland and 990 acres of pastureland are now adequately treated for all phases of soil and water conservation. The practices applied on these lands are reflected in Table 1A of the work plan. Approximately 8,230 acres of cropland and 4,060 acres of pastureland are now inadequately treated. The remaining land in the watershed, 2,700 acres consist of forest land, farmsteads, channels, roads, wildlife areas, and urban areas.

Most of the inadequately treated cropland involves soil capability classes II and III on the upland soils in the upper two-thirds of the watershed. Considerable row crop farming without conservation practices accounts for the soil erosion. Some steeper land being intensively cropped would be better suited for combinations of grasses, shrubs, and tree cover. Approximately 100 acres within the vicinity of Canby have a wind erosion hazard. Improved agricultural water management is needed on about 250 acres.

### Fish and Wildlife Resource Data

Wildlife values are fair to good in the watershed in comparison to wildlife census data for southern Minnesota. Species include ringneck pheasant, mallard duck, bluewinged teal, white tail deer, raccoon, red fox, mink, and muskrat. The watershed is located in the high pheasant range in Minnesota. Winter cover is limited over the lower one-half of the watershed. In the upper portion of the watershed there is a complex of approximately 65 type II thru VI wetlands totaling 619 acres. Most of these do not retain water throughout the summer. They do provide some production area and are used during the migration period.

White tail deer populations are low. They mainly utilize the woody stream bottoms and marshes.

Furbearer populations are limited because of limited permanent water areas in the watershed.

Fisheries in the watershed are limited to approximately eight miles of stream above town. Brown trout have been stocked annually since 1961. The stream is designated as a trout fishery by the Minnesota Department of Natural Resources.

Both fishing and hunting use are regarded as light to moderate.

## WATERSHED PROBLEMS

### Floodwater Damage

The major floodwater damages occur in the city of Canby and to crop and pasture land on the flood plain downstream from the State Highway No. 68. Floodwater damage also occurs to roads, bridges, and fences.

Floodwater damage occurs in the city of Canby from Canby Creek and county ditch No. 19 on the average of once every 5 years from rainfall floods and once every 7 years from snowmelt floods. Although snowmelt floods are not as frequent as rainfall floods, they cause more damage at the higher frequency levels. The average annual damage to the city of Canby is \$31,810 including indirect urban damages of approximately \$4,150.

Presently a total of 470 acres of cropland and pastureland are subject to damage from floods during the growing season. An additional 4,730 acres located downstream of the Canby Creek Watershed to the junction with Lac qui Parle River are also subject to flood damage. An estimated 110 acres flood annually within the watershed and 4,700 acres flood annually in the lake plain downstream of the Canby Creek Watershed to the junction with Lac qui Parle River. Within the watershed, approximately \$870 average annual damages including indirect damages occur to cropland and pasture. Other agricultural damages including indirect items amounts to \$230.

Downstream of the watershed, approximately \$80,000 average annual damages including indirect damages occur to cropland and pasture. Other agricultural damages including indirect items amounts to \$14,770. Damage to roads and bridges is estimated to be \$4,000 annually including indirect damages within the watershed. Downstream of the watershed these damages amount to approximately \$3,500.

On July 26, 1963, a severe rainstorm occurred in the watershed. Although no attempt was made to determine the extent of the storm, 5.23 inches of rain fell in three hours in Canby. This exceeds the 100-year frequency point rainfall for this area.

According to the Canby News, two people were injured (one hospitalized) and several families had to be evacuated from their homes with boats. Highway 68 was closed in both directions within the city limits where water inundated the highway. Highway 75 was inundated for three-fourths of a mile northeast of Canby.

A survey was taken to determine the monetary losses caused by this flood. Following is a summary of the results of the survey for the Canby area.

City of Canby Municipal Property	\$16,650.00
City of Canby Personal Property	18,369.10
City of Canby Business Property	12,013.70
Railroad Property	20,000.00
Farm Property	5,550.00
State Property	1,700.00
County Property	7,620.00
Total	<u>\$18,902.80</u>

It was felt by the local residents that loss of life and much more serious damage was prevented because of the numerous volunteers who were aware of the heavy rain and assisted in evacuating people and moving property to higher elevations.

#### Soil Erosion and Sedimentation

Upland sheet erosion is occurring on the sloping croplands southwest of Canby. The intensive row crop farming on long unbroken slopes produces high soil erosion rates. Present sheet erosion on these soils is estimated to be 13 tons per acre per year. Sheet erosion by water is not a problem on the lake plain area in the vicinity of Canby.

The annual sediment yield at the mouth of the watershed, including the area from county ditch No. 19, is estimated to be 42,000 tons per year.

Sediment from upland sheet erosion is being transported thru the natural stream system. This fine textured sediment is not causing significant damage to flood plains and channels but is being deposited in the Lac qui Parle Reservoir which is 35 miles below the outlet of the watershed. Unstable channel conditions on Canby Creek exist in the city of Canby.

The Canby Creek Watershed is less than one percent of contributing drainage area to the Lac qui Parle Reservoir. The Canby Creek Watershed is estimated at 3 percent of the sediment contributing area to the Lac qui Parle Reservoir.

Lake Sylvan, a small man-made reservoir in southwest Canby has been filled with sediment. The lake, however, still provides some aesthetic value.

#### Problems Relating to Water Management

##### Drainage

Cropland soils in the watershed having a wetness problem have prevented about 250 acres from being farmed at the most economical level. The wet soil conditions reduces yields and increased production costs. Some of the land is being used for pasture. Drainage outlets generally exist for these areas.



### Irrigation

There is no irrigation presently underway within the watershed. Ground water supply appears to be adequate for irrigation.

### Municipal and Industrial Water

Canby has a municipal water system consisting of four wells, three of them approximately 100 feet deep and one approximately 145 feet deep. The system is adequately serving the needs of Canby and should supply the future water needs. A stable water table exists.

### Recreation

Canby has three parks, each consisting of about four square blocks in size. They contain playground equipment, picnic areas, limited camping areas, ball playing fields, and a municipal swimming pool. These facilities, however, do not provide for the water-based recreational demands of the area. In addition, there are only limited lakes in the surrounding area, most of which have only fair recreational values for boating, swimming, and fishing.

Estimated population for Yellow Medicine County in 2000 is 12,175. This represents a decline in the population from 14,516 in 1970, and 15,523 in 1960, and 16,300 in 1950. An increase in recreational demand in the future will occur by an increase in leisure time and not by an increase in population.

The local people have shown considerable interest in developing additional recreational facilities. They realize the need for water-based recreational developments in their local community.

### Fish and Wildlife

There are significant acreages of wildlife habitat in the southwestern part of the watershed which provides winter cover for pheasants and nesting habitat for waterfowl. The marshes would, in some instances, be better maintained, preserved, or improved for wildlife habitat under public ownership. Additional winter cover areas, food plots, and nesting and brood cover are needed to improve wildlife habitat. This would include fencing marsh areas and shorelines. Level ditching is also needed in some wetland areas of poor quality to provide more permanent aquatic furbearer and waterfowl brood habitat within the watershed. Canby Creek has about eight miles of stream for trout fisheries which is stocked annually by the Minnesota Department of Natural Resources.

### PROJECTS OF OTHER AGENCIES

There are several existing water development projects, most of which are in the vicinity of Canby. These consist of three legal ditches, one mutual group ditch, one small dam, and a city storm sewer system.

County ditch No. 8 is the lower part of the Canby Creek and is the outlet for the major portion (26.8 square miles) of the Canby Creek Watershed. County ditch No. 19 is located on the northwest corner of Canby and is the outlet for the remaining 4.7 square miles. Except for a culvert replacement, there are no improvements planned for this channel. County ditch No. 55 drains into Canby Creek approximately six miles above Canby and will not be affected by the planned improvements.

The Miller Group, a mutual group ditch, is located east of Canby and drains into the Lac qui Parle River. Landowners desire improvement of the channel conditions.

Lake Sylvan, in the southwest corner of Canby, is controlled by a structure and has a small 7-acre reservoir immediately upstream of the U.S. Highway 75. Ottertail Light and Power Co., at one time, used the lake water for a coolant for their standby plant. At present and in the future, the lake will most likely be used for its aesthetic values which will be enhanced with the reduction of flood flows.

Approximately 0.5 mile of storm sewer was recently installed on the west side of Canby to alleviate the flooding in that part of the city. The flooding is caused by runoff from the watershed west of the railroad. The storm sewer is not of sufficient size to control flooding of the higher frequency storms. There is a network of storm sewers to provide drainage for the city.

For location of these water developments, except the network of city storm sewers, see the Water Development Project Map (Figure 1).

### PROJECT FORMULATION

The local sponsors set forth the following objectives in their application for the formulation of a comprehensive plan for the Canby Creek Watershed.

1. Reduce sheet erosion in the upland moraine area of the watershed with improved land treatment to help stabilize and increase farm income.

2. Provide flood protection in the urban area of Canby and areas that are planned for future urban development. Reduce flood-water damage to cropland, roads, and bridges on the flood plains of Canby Creek, county ditch No. 19, and the Miller Group Watersheds.



3. Provide a better outlet for the Miller Group Ditch to improve drainage outlets.

4. Incorporate a plan for water-based recreation in the design of one floodwater-retarding structure on Canby Creek.

In order to accomplish these project objectives, it was agreed by the Sponsors and the Soil Conservation Service that the following measures and degrees of protection should be included in the plan:

1. Intensify the installation of soil conservation practices so that 75 percent of the cropland and pastureland in the watershed will be adequately treated. This will include an accelerated land treatment program in order to adequately treat an additional 45 percent of the crop and pasture land during the project installation period.

2. Provide 100-year frequency flood-free protection to the present and future area of Canby and 5-year flood-free protection to the agricultural flood plain by installing floodwater-retarding structures on Canby Creek and one above county ditch No. 19 are economically feasible.

3. Provide a plan for water-based recreation development as part of the lower floodwater-retarding structure on Canby Creek. In view of the large water-based recreation demand anticipated in the area, the sponsors desired an extensive recreation development.

4. Provide for installation of stream-channel stabilization measures to the channel within the city of Canby.

5. Insure aesthetically pleasing land use and proper maintenance of Canby Creek through the city of Canby and downstream to the outlet at St. Leo Road. This will include land and gravel mineral rights sufficient to insure continued bedload movement downstream.

6. Continue to provide for operation and maintenance of the Lake Sylvan control structure.

In developing the plan, it was found that a combination of land treatment and structural measures was the most desirable alternative to meet the objectives of the Sponsoring Local Organizations. The following describes the formulation process followed in arriving at the best plan for this alternative.

On the county ditch No. 19 subwatershed, two floodwater-retarding structures and channel improvement were initially considered in this plan. The two floodwater-retarding sites

were investigated to determine if one or the other sites would obtain the degree of protection desired by the local people. Structure R-4A proved to be the most economical solution. Channel improvement was not needed because the desired degree of flood prevention was obtained with the one single-purpose floodwater-retarding structure.

Three floodwater-retarding structures were initially studied on Canby Creek upstream from the city of Canby. The upper site (R-3) was eliminated because an alternate site (R-2) had better storage potential. This site R-2 was studied for floodwater reduction and recreational potential. Site R-2 would not provide the required degree of flood prevention in Canby without channel improvement. Structure R-1, which is located approximately 1 mile upstream of U.S. Highway 75, was studied for floodwater retention and recreation. When comparing the least expensive combination to get the desired degree of protection, structure site R-1 was found to be a more economical solution. Further investigations indicated that an additional structure site (R-6) in series with R-1 would be more economical than R-1 alone.

Because of unstable channel conditions on a recently constructed channel in Canby, stream channel stabilization measures were determined to be necessary as part of the plan.

The installation of R-2 or R-3 instead of R-1 and the resulting need for channel improvement was estimated to cost about \$1,500,000. This exceeded the cost of structure R-1 and would destroy more of the aesthetics of the natural setting of Canby Creek through Canby. The channel improvement would also increase the operation and maintenance cost.

Two areas originally included in the watershed were subsequently eliminated during project formulation. These areas are the Miller Group subwatershed and the lower portion of Canby Creek known as county ditch No. 8.

It was decided that problems on county ditch No. 8 could best be handled with a thorough and improved maintenance program directed by the existing legal ditch authority. Studies on the county ditch No. 8 system showed areas of streambank erosion and the lack of surface water inlets. In addition, there is movement of the bedload to provide bed armouring material in the channel.

Investigations determined that the side water inlet problem and streambank erosion could be greatly improved under a maintenance program. There is, at the present time, a legal entity of government that has operation and maintenance responsibilities for county ditch No. 8. Since there is a legal entity of government responsible for the channel, and corrective measures can be applied, it was agreed not to include the county ditch No. 8 system as part of the project.



In the Miller Group subwatershed, two single-purpose floodwater-retarding sites along with combinations of greased floodways with tile and multipurpose channel were investigated to outlet into county ditch No. 8. This would have provided a new outlet for this watershed. Investigations of the alternate structure sites showed that the potential structures would not have an appreciable effect on the reduction of floodwater damages. The grassed floodways and multipurpose channel were investigated to meet the objectives of the sponsors. These measures would have outlet into county ditch No. 8. Because of the erosion problem on county ditch No. 8, it was determined not advisable to outlet the Miller Group subwatershed into the county ditch. This would have allowed additional floodwater to enter the county ditch No. 8 system, possibly intensifying the erosion problem. Alternatives were considered to outlet the Miller Group into the Lac qui Parle River. These alternatives were not feasible from an economic viewpoint. Therefore, the Miller Group subwatershed was not included in the plan.

In addition to the selected alternative of a combined land treatment and structural measures product, several other alternatives were considered as part of the development of this plan. Alternatives considered and their effect are as follows:

1. Flood Plain Zoning - A flood plain zoning program could be developed by limiting the future expansion of business and residences in the flood plain. The cost of this would be for the enforcement of the flood plain zoning laws. However, this would not alleviate the existing urban damages that are occurring from floodwaters.

2. Floodproofing - Floodproofing of existing businesses and residences within the watershed was considered. This would protect the existing establishments in the urban areas but would not solve the flood damage problems in the agriculture areas. This type of floodproofing program is estimated to cost approximately \$1,000,000. Again, this would be only a partial solution and would not significantly contribute to the rural development of the area.

3. Flood Insurance - The losses as a result of floodwaters with public relief in the form of flood insurance is possible. However, this does not resolve the flooding problems in the area and does not assist the individual in trying to improve living conditions. Cost of this alternative was estimated to be \$20,000 annually. Reimbursed damages would amount to about \$13,000 annually. Other flood damages not covered by flood insurance would be about \$122,000 annually.

4. Single-Purpose Recreation - A single-purpose water-based recreation development is also a consideration. This would involve a dam in the vicinity of R-1 solely for the purpose of recreation. This was estimated to cost approximately \$1,100,000 compared to \$1,200,000 that is planned for the multipurpose structure. Remaining uninvolved would be all the water management problems.

5. Land Treatment Only - Conservation land treatment measures were considered, at an estimated cost of \$209,100. This alternative would not provide the degree of flood prevention that is needed to improve the local economy of the area. Although land treatment does help prevent soil erosion and water loss, it does not provide for the degree of damage reduction necessary to improve the economic factors within the flood-prone areas.

#### WORKS OF IMPROVEMENT TO BE INSTALLED

##### Land Treatment Measures

The land treatment measures planned in the watershed will make an important contribution to the project objectives. The application of adequate soil and water conservation measures will reduce soil losses due to water erosion, increase the permeability of the soil, promote the proper use of soil and water resources, as well as provide a more economical design of the structural measures. The accelerated land treatment program planned to be installed during the project period includes practices that will adequately treat an additional 5,000 acres of cropland, 2,500 acres of pastureland, 50 acres of other land managed for wildlife, and 110 acres of forest land.

Farmers and landowners will be urged through local Soil and Water Conservation Districts to use good management in the use of fertilizers and pesticides along with appropriate conservation practices to minimize water quality degradation downstream.

The expected application of contour farming, stripcropping, terraces, and/or diversions along with minimum tillage will adequately treat the cropland possessing erosion problems. Installation of grasses waterways and grade stabilization structures will treat several existing gully conditions. Two or more combinations of measures may be needed to achieve adequate land treatment. The Technical Guides, located in the local Soil Conservation Service Work Unit Offices, contain various alternatives for adequately treating erosion conditions.

Drainage field ditches and drains planned to be installed will adequately treat the cropland possessing excessive water problems. Eliminating these problems will encourage more efficient farming operations as well as provide a larger reservoir for infiltration of water.

Improved pasture and hay land management expected to be applied along with the installation of ponds and pits will properly treat the grassland areas. Wildlife wetland habitat management practices will maintain and improve the wildlife areas planned for treatment during the project period.

The Sponsoring Local Organization estimates that 37 additional landowners or operators will become cooperators with the Soil and Water Conservation Districts and that 60 additional landowners or operators will develop soil and water conservation plans on their farms during the project period with technical assistance from the Soil Conservation Service. The Sponsoring Local Organization, with Soil Conservation Service assistance, will make the necessary contacts to plan and apply the needed land treatment measures. Approximately 6,400 acres in the watershed do not have the necessary soil surveys to properly develop soil and water conservation plans. Twenty man days of technical assistance are needed to complete the soil surveys.

Proper management and appropriate forest land treatment measures will be applied to 110 acres of land. This will principally involve the control of woodland grazing and the installation of tree planting practices. Guidance to forest landowners will be provided by the District Forester, Minnesota Department of Natural Resources, Division of Lands and Forestry, through the preparation of management plans for lands to receive protection or treatment measures. Additional technical assistance will be provided during the installation of proposed measures.

Other forestry assistance will also be available from the District Forester to provide for planning and achieving tree planting measures within the public recreation development around structure R-1.

Fifty percent of the land upstream of the structural measures will be adequately treated with the application of conservation practices, prior to construction of the structural measures. In addition, conservation plans will be required on 50 percent of the area prior to construction.

### Structural Measures

#### General

The structural measures planned to meet the project objectives include the following: One multiple-purpose floodwater-retarding-recreation development, two single-purpose floodwater-retarding reservoirs, and approximately 0.8 mile of stream channel stabilization. Recreation facilities will be provided for the recreation development planned with the multiple-purpose reservoir.



Structures R-1, R-6, and R-4A control a combined drainage area of 28.19 square miles of the 30.2 square miles above State Highway No. 68. Thus, 93 percent of the area immediately above the major damaged area will be controlled by these three structures.

The three retarding structures control an area of 28.19 square miles of the total 32.0 square miles, providing 88 percent control at the outlet of the watershed.

#### Single-Purpose Flood Prevention Structures

Structure R-4A is planned to provide protection for the northwest part of Canby. The structure controls 2.36 square miles and is designed to store the accumulated sediment for a 100-year period. The principal spillway for the structure will have the crest elevation at the 50-year sediment pool level making this the permanent water level for the first 50 years. The surface area of the 50-year sediment pool is approximately 13 acres.

The single stage principal spillway is designed to control flood events that occur once in 100 years. The emergency spillway is expected to operate an average of once in 100 years. There is a total available storage of 505 acre feet to the emergency spillway; 216 acre feet of sediment; and 289 acre feet for flood detention.

With the installation of structure R-4A, the peak discharge will be reduced 73 percent immediately below the structure for a flood that occurs once in 5 years. The future discharge for the 100-year frequency flood is likewise reduced 89 percent.

The principal spillway for the structure will be constructed of reinforced concrete pipe, a reinforced monolithic concrete riser, and cantilever outlet with an excavated stilling or concrete impact basin. The spillway will be constructed on preconsolidated glacial till (CL) foundation. The stilling basin will likely be constructed in a buried glacial outwash sand deposit (SM and SP-SM).

The vegetated emergency spillway will be constructed in preconsolidated till (CL) which is erosion resistant. Good vegetative cover is expected on this type of soil. R-4A earth embankment will be constructed of glacial till (CL).

Structure design data is listed in table 3, pages 43, 44, and 45. A typical cross-section of the single-purpose flood retarding structure is shown in exhibit 1, page 66. Cost data is on table 2, page 39. The structure location is shown on the project map.

Structure R-6 is planned in series with R-1, and it will assist R-1 in providing flood protection in Canby and agricultural areas further down stream. The structure controls 15.46 square miles. It is designed to store the accumulated sediment for a 100-year period. The principal spillway will have the crest elevation at the 100-year

sediment pool level. Since the structure is designed as a dry sediment pool, the riser will be so placed and designed with drawdown ports that it will discharge water at lower elevations to insure a dry pool.

The single stage principal spillway is designed to control flood events that occur once in 100 years. The emergency spillway is expected to operate an average of once in 100 years. This reservoir stores 391 acre feet of sediment and 2,206 acre feet of water for flood protection for a total of 2,597 acre feet to the emergency spillway.

With the installation of structure R-6, the peak discharge will be reduced 82 percent immediately below the structure for a flood that occurs once in 5 years. The 100 year frequency will likewise be reduced 92 percent.

The principal spillway for R-6 will be constructed of reinforced concrete pipe with a reinforced monolithic concrete rise. The outlet works will be a reinforced monolithic concrete (St. Anthony Falls) stilling basin. The spillway can be constructed on preconsolidated glacial till (CL) foundation. The stilling basin will likely be constructed in a sandy pervious glacial melt-water deposit which is a mixture of sands, gravels, and very large boulders (SC, SM). Borings indicate a preconsolidated glacial till (CL) from 6 to 8 feet below footings of the outlet.

Structure R-6 will function as a fish barrier and before final engineering designs are prepared, a decision will be reached on proper design. This decision will be jointly made by the Sponsoring Local Organization, Soil Conservation Service, Minnesota Department of Natural Resources (Division of Game and Fish), and the Fish and Wildlife Service.

The vegetated emergency spillways (one on each side) will be constructed in preconsolidated glacial till (CL) which is erosion resistant. This material will produce good vegetative cover.

The earth embankment will be constructed of glacial till (CL).

Structure design data is listed in table 3, pages 43, 44, and 45. A typical cross-section of the single-purpose flood retarding structure is shown in exhibit 3, page 68. Cost data is on table 2, page 39. Structure location is shown on the project map.

The entire farmstead at the dam site and the majority of the land will be occupied by the floodwater-retarding structure and pool area. A family of six and their farm operations will be displaced.

### Multiple-Purpose Structure

Structure R-1 is planned for floodwater-retarding and recreation use. This structure operates in series with R-6 and controls an additional 10.37 square miles. Total area controlled above R-1 is 25.83 square miles.

The structure is designed for a useful life of 100 years and will store the expected sediment for this period. Available storage at the crest of the emergency spillway provides 1,026 acre feet for sediment, 1,203 acre feet for recreation use, and 1,776 acre feet for flood detention, for a total storage of 4,005 acre feet. The surface area of the recreational pool is 147 acres.

The principal spillway is designed to control floods that occur once in 100 years. The emergency spillway will operate an average of once during this period. The structure will have a single stage principal spillway.

The principal spillway will have a cold water release incorporated for fisheries management and a drawdown device for structure maintenance and fisheries management.

With the installation of structure R-1, the peak discharge will be reduced 64 percent immediately below the structure for a flood that occurs once in five years. The discharge for the 100-year frequency flood will be reduced 87 percent.

The principal spillway for the structure will be constructed of reinforced concrete pipe with a reinforced monolithic concrete riser. The outlet works will be a reinforced monolithic concrete (St. Anthony Falls) stilling basin. The principal spillway will be constructed on preconsolidated glacial till (CL) foundation, which is underlain at greater depths by glacial lake sands, silts, and clay deposits.

The emergency spillway will be constructed and vegetated in preconsolidated till (CL).

Riprap will be placed on the upstream face of the dam to prevent erosion by wave action at the permanent pool elevation.

The design data is listed in table 3, pages 43, 44, and 45. Exhibit 2, page 67, shows the cross-section of this multiple-purpose structure. Cost data of the structure is in table 2, page 39. The project map shows the location of this structure.

A farmstead and surrounding land will be occupied by the R-1 multiple-purpose reservoir and recreation development. One couple will have to be displaced. Since the couple is near retirement, there will probably be no farm operations to displace.



### Recreation Facilities

The recreational development is planned on 275 acres of land adjacent to the 147 acre lake with an initial maximum depth of approximately 40 feet. The types of recreation planned include picnicking, overnight camping, boating and canoeing, fishing, swimming, and hiking. The basin facilities for the various recreational activities include picnic tables, grills, toilets (flush and vault), garbage stations, playground equipment, boat launch and dock, sand swimming and bath house, parking areas and paved access roads, sewer lines to the city sewer system, power lines with appurtenances for lights, and outlets for recreational camping vehicles, water supply for drinking and showers, and hiking trails. Provisions will be incorporated to provide necessary features to insure facilities are available for use by the handicapped. All critical erosion areas will be treated with appropriate measures. Cost and amounts of the facilities is found in table 2B, pages 41 and 42. For plan of the recreational development, see Figure 2.

### Stream Channel Stabilization on Canby Creek

Canby Creek from Highway 68 to St. Leo Road required stabilization in the upper portion of the reach.

The upper portion of this reach from Highway 68 to the township road will include 2 grade stabilization structures and 0.8 mile of stream channel stabilization. The purpose of the measures is to reduce streambank and channel bottom erosion. The lower structure (see location on project map) will be installed near the sand and gravel plant in the northeast part of Canby and the upper structure will be located approximately 0.5 mile upstream from the lower structure.

Both are planned as concrete box inlets to culverts. The lower site is planned with a road crossing to replace the present crossing.

The structures are designed to pass the flow of a 100-year frequency flood event. They will operate as island-type structures in case the inlet boxes become clogged with ice and/or trash.

The channel modification will be limited in amount to provide a sufficient approach and exit channel for the grade stabilization structures.

Stabilization measures will be installed in glacial lake deposits. The materials vary throughout the construction area from clay (CL) to silty sands and fine sands (SM-SC).



The project map shows the location of these structural measures in the watershed. Channel and structure data summaries are found in tables 3A and 3B, pages 46 and 47. Cost estimates are given in table 2, page 39. Exhibit 4, page 69, illustrates a typical cross-section of the channel.

#### Nonstructural Measures

##### Natural Stream Conditions on Canby Creek

With the installation of the multiple-purpose structure R-1, the channel regime of county ditch No. 8 will need the continued source of gravels to remain in balance. The portion of Canby Creek from the St. Leo Road upstream to the north-south township road will be preserved in its natural condition. Gravel and mineral rights, in addition to the other necessary land rights, will be obtained on 18 acres along the lower 2,000 feet of Canby Creek. This measure is needed to insure the necessary source of gravel material for the continued natural armor plating of the channel bed of county ditch No. 8.

##### Cultural Assessment

A cultural (historic, archeological, architectural) assessment of Canby Creek Watershed will be conducted prior to beginning construction. The Minnesota Historical Society will be requested to conduct this survey and assessment. If affected cultural resources are encountered, a salvage and/or preservation program will be developed in association with the Sponsors, Soil Conservation Service, Minnesota Historical Society (State Historical Preservation Officer), and U.S. Department of the Interior, National Park Service.

##### Water Quality Monitoring

A complete water quality monitoring program will be established to begin about one year before construction commences. The program will extend through the construction period and for about one year beyond. Samples will be obtained during low flows, storm flows, and during planting, harvesting, and growing seasons. The Soil Conservation Service and the Sponsors will seek an Environmental Protection Agency and/or State agency grant to obtain necessary funding.

The monitoring program will also obtain data required to assess the impact on downstream water quality of discharging bottom (hypolimnion) waters from structure R-1 which may be low in oxygen and high in nutrients and pollutants.

EXPLANATION OF INSTALLATION COSTS

Land Treatment

The total cost of installing land treatment measures is \$209,100. The installation cost of \$174,800 will be met by the landowners and operators on whose farms the measures will be installed. Cost sharing from other programs such as Rural Environmental Assistance Program, may contribute part of the construction cost. Technical assistance in the application of these measures is estimated at \$34,300 of which \$32,400 will be provided by Public Law 566 funds necessary for acceleration of the land treatment program to meet project goals. The remaining \$1,900 will be provided by the existing Soil Conservation Service program and the Minnesota Department of Natural Resources. Land treatment cost is summarized in table 1, pages 36 and 37.

Cost estimates of installing land treatment measures on cropland and pastureland are based on average costs presently encountered for their installation in the Canby Creek area. Costs for needed technical assistance is based on summary cost data of the Soil Conservation Service.

Costs for the installation of forest land treatment measures are based on current costs of supervision, labor, equipment, and materials required to accomplish and specific measures. Cost for technical assistance needed in the installation of forest land treatment measures are based on analysis of records of the Minnesota Department of Natural Resources, Division of Lands and Forestry.

The schedule of estimated land treatment costs needed for each fiscal year during the installation period is as follows:

<u>Fiscal Year</u>	<u>Public Law 566 Funds</u>	<u>Other Funds</u>
First	\$8,000	\$35,000
Second	7,400	45,000
Third	7,000	42,000
Fourth	4,000	20,000
Fifth	3,000	15,000
Sixth	2,000	12,000
Seventh	<u>1,000</u>	<u>7,700</u>
TOTAL	\$32,400	\$176,700

Structural Measures

The total installation costs for structural measures include all construction, engineering, land rights, and project administration cost paid by both Public Law 566 and other funds. They are shown in detail in table 2, page 39.

Construction costs are the engineers' estimates of the costs of all materials and labor involved in constructing the measures. Items included are: furnishing materials, clearing and obstruction removal, excavation, placing earth fills, concrete placements, seeding, fencing, placing of riprap, and other necessary work. Unit costs were calculated on the basis of current prices for similar construction work in Minnesota. A 12 percent contingency allowance is added to defray any additional cost which might arise during construction.

Construction costs of the multipurpose structure is estimated at \$668,800. The \$668,800 is considered as a joint cost serving both flood prevention and recreation. The joint costs were allocated between flood prevention and recreation purposes by the "Use of Facilities". Flood prevention and sediment storages comprise 70 percent while recreation storage is 30 percent of the total storage. Total cost allocated to flood prevention is \$468,000 while \$200,800 is the cost allocated to recreation. Since Public Law 566 funds will pay 100 percent of the construction costs for flood prevention and 50 percent of the cost for recreation, the Public Law 566 share of the joint costs is \$568,400 while the other than Public Law 566 share is \$100,400.

The construction cost of the recreational facilities is estimated at \$205,600. Public Law 566 will pay 50 percent of the cost for basic facilities, therefore, the local share is \$102,800 and the Public Law 566 share is \$102,800.

Construction costs for the stream channel stabilization measures will be paid with Public Law 566 funds. This amounts to \$37,500. The additional cost is providing a road crossing on the lower stabilization structure in the Canby Creek is \$2,000. This is a non-project cost and will be paid by other than Public Law 566 funds.

The total cost of relocation payment is estimated at \$12,000 of which \$8,400 is Public Law 566 costs and \$3,600 is other costs. The total costsharing arrangements is based upon the ratios of Public Law 566 funds and other funds to the total project including relocation assistance advisory services.

Engineering costs which are paid 100 percent by the Soil Conservation Service includes cost for required surveys, investigations, design, and preparation for plans and specifications for all structural measures except recreational facilities. An engineering contract is needed for the recreation facilities of which Public Law 566 funds will pay for 50 percent of the contract. The Public Law 566 share of engineering services is \$188,500 for the entire project and the other than Public Law 566 share is \$10,300.



Public Law 566 project administration costs include the cost of administration, review of engineering plans developed by others, construction surveys, government representatives, necessary inspection services during construction, and the administrative function in connection with relocation payments and assisting the Sponsoring Local Organization with relocation assistance advisory services. The total Public Law 566 project administration costs are estimated to be \$173,700. Local project administration costs include administration of contracts, legal fees, clerical, any construction inspection they may perform, relocation assistance advisory services, and administrative cost associated with making relocation payments.

The relocation assistance advisory services may include: Determination of relocation needs, providing information on availability of housing and farm operations, assuring replacement dwellings, assisting any displaced person to minimize hardships and become established again, supplying information on Federal and State programs offering assistance, and providing any displaced person a brochure outlining the benefits they may be entitled to. Administrative functions in connection with relocation payments may include: Serving notice of displacement, providing appropriate forms, assisting in filling applications, hearing and resolving grievances, and in making relocation payments.

The cost of providing relocation assistance advisory service is a sponsor responsibility and is estimated to cost \$4,800. The administrative functions connected with relocation are a part of the "Other" costs shown on table 1 under "Project Administration". The Sponsoring Local Organization and the Service will each pay these costs as they are incurred. Total other project administration services costs are estimated to be \$34,300.

Land rights includes costs of obtaining land required for structural measures, any appraisal fees, modification of roads and driveways, installation of new bridges, obtaining land for borrow materials, and obtaining mineral rights on Canby Creek at the lower end of the watershed. Appraisal fees will be required for a qualified appraiser to obtain the fair value of when relocation costs are involved. These costs are included as part of the land rights cost of the project. The total cost of land rights for the project measures is estimated at \$300,800. The total land required for the multiple-purpose development is 670 acres. There is 615 acres of land needed for the recreational development and 55 acres needed in addition for flood prevention purposes. The \$92,000 to be paid with Public Law 566 funds is 50 percent of the cost of 615 acres of land rights to be acquired by the Sponsoring Local Organization for the public recreation development. Of the 615 acres eligible for cost-sharing, 340 acres are required for the reservoir and 275 acres needed for the basic facilities. The 55 acres for flood prevention purposes will not be cost-shared with the Sponsoring Local Organization.



The total local share of the land rights cost is \$208,800 which includes \$6,500 for the replacement of a road culvert in county ditch No. 19 located at the northeast corner of section 4, T. 114 N., R. 45 W. Also included is \$11,700 for stream channel stabilization and maintenance of natural stream conditions along Canby Creek from State Highway No. 68 to St. Leo Road. Land rights including gravel mineral rights for the lower 2,000 feet of Canby Creek will insure that the natural condition is not disturbed. No cost-sharing will be provided for the engineering, legal, or administrative costs incurred by the local organization for acquiring land rights. The entire cost of the project, including land treatment and structural measures, is estimated at \$2,105,600. The Public Law 566 share is \$1,468,700 or 69.7 percent of the total. The local share is \$636,900 or 30.3 percent. See cost summaries in tables 1, 2, and 2A, pages 36, 37, 39, and 40.

The schedule of estimated structural project costs needed for each fiscal year during the installation period and the probably construction schedule is as follows:

<u>Fiscal Year</u>	<u>PL 566 Funds</u>	<u>Other Funds</u>	<u>Completion Schedule</u>
First	92,000	11,400	Organize watershed district as legal entity of government. Design and prepare engineering court plans for structures R-1, R-6, recreation facilities, and stream channel stabilization measures.  Project Administration Costs
Second	45,000	6,000	Watershed District accepts petitions and engineering court plans for structures R-1, R-6, recreation facilities, and stream channel stabilization measures; handles hearing and appeals, and orders in project. Prepares contract plans and specifications for structure R-6. Obtains other than PL 566 monies for R-6.  Project Administration Costs
Third	285,600	78,000	Design and prepare engineering court plans for structure R-4A. Prepare contract plans and specifications for structure R-1. Let contract and construct structure R-6.

<u>Fiscal Year</u>	<u>PL 566 Funds</u>	<u>Other Funds</u>	<u>Completion Schedule</u>
			Obtain other than PL 566 monies structure R-1.
			Project Administration Costs
Fourth	671,700	161,300	Watershed District accepts peti- tion and engineering court plans for structure R-4A, handles hearing and appeals, and orders in project. Prepare contract plans and specifications for structure R-4A. Let contract and construct structure R-1. Obtain other than PL 566 monies for structure R-4A.
			Project Administration Costs
Fifth	112,000	35,000	Prepare contract plans and specifications for stream channel stabilization measures. Let contract and construct structure R-4A. Obtain other than PL 566 monies for stream channel stabilization measures.
			Project Administration Costs
Sixth	65,000	20,500	Prepare contract plans and specifications for recreational facilities. Let contract and construct stream channel stabili- zation measures. Obtain other than PL 566 monies for recreation facilities.
			Project Administration Costs
Seventh	165,000	148,000	Let contract and construct the recreation facilities.
			Project Administration Costs
TOTAL	1,436,300	460,200	

## EFFECTS OF WORKS OF IMPROVEMENT

### Land Treatment Measures

The effects of the land treatment measures to be installed will be to provide conservation benefits through land improvement, reduced erosion, and improved water management. Conservation practices will allow the soil to absorb more water and reduce sedimentation which reduces the required design capacities of floodwater-retarding structures and channels. The land treatment measures will reduce sediment yield at the outlet of the watershed by 50 percent. Vegetative land treatment measures will also provide improved wildlife habitat conditions. The planned land treatment to be applied will increase cropland adequately treated from 4,170 to 9,170 acres and pastureland adequately treated from 990 to 3,490 acres. Watershed values will be protected or improved as a result of the proposed forest land treatment program. Wildlife habitat and the quality of the environment will also benefit.

### Structural Measures

After installation of the combined program of land treatment and structural measures described above, the 100-year frequency flooded area in the watershed will be reduced from 470 to 100 acres. The 4,730 acres subject to flooding downstream of the watershed to the junction of Lac qui Parle will be reduced to 3,610 acres. Reduction in area inundated varies with respect to location within the flood plain.

The effect on average annual flooding of all expected floods within the 100-year period in each reach is shown on the following table:

Evaluation Reach <sup>1/</sup>	Average Annual Acres Inundated		
	Without Project	With Project	Percent Reduction
A, B, C, E, F, & G (outside watershed)	3,840	3,185	17
1, 2, & 3 (outside watershed)	356	285	20
4, 5, & 6 (outside watershed)	493	122	72
7 through 12 & 20	58	0	100
13 & 14	53	8	85
TOTAL	4,800	3,600	25
Total (within watershed)	111	8	93

<sup>1/</sup> See project map for location of reach.



The following table shows, by reaches, the expected reduction in area flooded from the 2 year and 5 year frequency floods:

Evaluation Reach <sup>1/</sup>	Acres Inundated			
	Average Recurrence Interval			
	2 year		5 year	
	Without Project	With Project	Without Project	With Project
A, B, C, E, F, & G (outside watershed)	2,025	1,700	2,560	2,300
1, 2, & 3 (outside watershed)	145	130	250	170
4, 5, & 6 (outside watershed)	309	40	553	210
7 through 12 & 20	28	0	67	0
13 and 14	43	0	100	0
TOTAL	2,550	1,870	3,530	2,680
Total (within watershed)	71	0	167	0

<sup>1/</sup> See project map for location of reach.

Flooding within the city of Canby caused by the overflow of a 100-year frequency flood from Canby Creek will be controlled. The estimated peak discharge from a 100-year frequency rainstorm flood on Canby Creek in the city of Canby is 3,821 cfs under present conditions. With structures R-1 and R-6 in place, this discharge will be reduced to 505 cfs, a reduction of 85 percent.

Average annual crop and pasture damages and other agricultural damages such as fence damage, removal of debris, increased weed infestation, etc., within the benefited area of the watershed will be reduced by 90 percent with the project. Downstream of the watershed these damages will be reduced approximately 18 percent on 4,730 acres. Although structure R-1 reduces the total area flooded and the depth of the floodwaters in the flood plain between the outlet of Canby Creek and the Lac qui Parle River, prolonged flow from the structure will cause flooding for longer periods of time on approximately 360 average annual acres of low lying cropland and 105 average annual acres of pasture. Approximately 50 farm landowners will be benefited with the project, 40 of which are located outside of the Canby Creek Watershed.

Average annual floodwater damages will be reduced by 80 percent to 15 bridges and section of roads of which 10 are located within the watershed and 5 immediately downstream of Canby Creek Watershed. The structural measures will reduce sediment delivered to the outlet of the watershed by an additional 41 percent.

The structural measures and land treatment is estimated to reduce sediment deposition in the Lac qui Parle Reservoir by 15 percent.



Flood-free protection up to and including a 100-year frequency flood will be provided to 60 residence and business properties along Canby Creek and 85 residence properties adjacent to county ditch No. 19. The area subject to remaining damages with the project lies one mile north of Canby near county ditch No. 19 which includes Town and Country Bowling Lanes and the Johnson home and business. For this area flood-free conditions will be increased from approximately the present 2-year frequency flood to the 5-year frequency flood. The project will reduce the average annual damage for this area by 55 percent. About 12 undeveloped properties will increase in value with the reduction of the flood hazards.

The reduction of frequent flooding will permit approximately 235 acres in the watershed to be farmed with a higher level of management. Of this, 125 acres lies in sections 33 and 34 downstream of the R-4 structure and 110 acres lie adjacent to Canby Creek downstream from the city of Canby. An additional 1,160 acres located adjacent to county ditch No. 8 outside the watershed will also be benefited. Increased yields as well as lower average production costs per unit of yield will increase the net income from the above benefited areas. The increased net income will help to supplant the income of the farm owners and operators located in the flood plain.

Multiple-purpose structure R-1 will provide 1,203 acre feet of storage for recreation use. Rainfall and runoff volumes are adequate to maintain a pool of this capacity at a reasonably stable level. This provides a lake area of approximately 147 acres situated in a 275 acre recreation development. The recreation development will provide 47,800 visitor days of recreation annually at an estimated value of \$1.50 per visitor day. The peak daily use is expected to be 835 visits. Recreation activities will include picnicking, swimming, boating, fishing, hiking, camping, and ice skating. Tree and shrub plantings will be made with species having wildlife food cover values.

The stream channel stabilization and maintenance of natural conditions on Canby Creek from Highway 68 to St. Leo Road will provide stable channel conditions in the upper portion of the reach and protect the desirable movement of bedload in the lower portion. Throughout the entire reach, land rights will allow proper maintenance access and preservation or improvement of the aesthetic and wildlife values.

There will be approximately 1,020 acres of cropland and pastureland removed from agriculture production with the installation of the three retarding reservoirs.

The installation of multiple-purpose structure R-1 will result in the elimination of 35 acres of streamside woody vegetation and about one and one-half mile of marginal trout stream.

The planned structural measures will have no effect on the wetlands in the upper reaches of the watershed.

This project will provide social benefits and contribute to the rural development by providing more stable income from local sources. By improving the livability in the city of Canby and surrounding area, the present population will have more incentive to stay.

The effects on the local economy, due to a delay of the project for one year, would include the damages from flooding of the agricultural areas and the transportation facilities valued at \$22,620, the flood damage of the urban areas valued at \$30,050. The foregone benefits from more intensive land use of present flood prone cropland valued at \$6,250, the foregone benefits from enhancement of undeveloped urban areas valued at \$3,170, and the foregone recreational activities valued at \$71,700. The annual net benefits foregone would amount to \$22,940.

Benefits of \$15,380 would also be foregone primarily to the wholesale, retail, and service sector of the economy. The foregone benefits would not be realized by the transporting, processing, and marketing industries that would handle the increased population of crops and that would supply the additional materials and services required to make possible the increased production on the area to be benefited. The additional materials and services would amount to 17 tons of fertilizer worth \$1,800 and \$3,000 of increased harvesting charges. The harvesting charges include the fuel, machinery, and storage industries. An additional \$3,700 service charge would involve the fuel and machinery industries and increased labor needs for the average installation of the needed buried drains.

If this project were not implemented, the annual net benefits of \$22,940 would be foregone. The present value of all project benefits foregone for the 100-year evaluation period would be \$2,711,000.

#### PROJECT BENEFITS

Total monetary benefits that will accrue when the structural measures are installed are estimated to equal \$146,500 annually. The primary benefits were derived from the reduction of damages due to floodwaters (\$50,000), from more intensive land use (\$6,250), from urban enhancement (\$3,170), and from the recreational development (\$71,700). The flood prevention purpose will account for benefits of \$65,900 and recreation purpose for the remainder or \$80,600. In addition, the installation of land treatment measures will provide \$2,670 flood damage reduction benefits. Of the total benefits, \$15,380 are secondary benefits that will accrue to local processors and handlers of watershed produced goods and services. Secondary benefits from a national



viewpoint were not considered pertinent to the economic evaluation. Average annual benefits exceed average annual costs resulting in annual net benefits of \$22,940. See tables 5 and 6 for evaluated benefits, pages 49 and 50.

The tables include floodwater damages outside watershed boundary of \$98,270 and also include damage reduction benefits of \$17,990. Damage reduction benefits of \$28,530 minus the \$10,540 caused by the prolonged flow of R-1 will provide a net benefit of \$17,990. Farms affected by the prolonged flows will, however, also be benefited by the reduction of peak flows.

Substantial unevaluated benefits will accrue in this watershed. The planned land treatment measures and the structural measures will improve the hydrologic conditions of the watershed, thereby increasing infiltration rates and reducing runoff and soil losses. Wildlife values in the form of habitat management will be provided by planting trees, shrubs, and permanent herbaceous vegetation with the land treatment measures within the recreation area development as well as on the other works of improvement. In addition, water pollution will be reduced. Canby's sewage disposal system located on the flood plain will no longer be subject to flood conditions. Without the project, the sewage plant is subject to flooding which results in raw sewage being discharged into Canby Creek.

#### COMPARISON OF BENEFITS AND COSTS

The ratio of the average annual benefit to average annual cost for the Canby Creek Watershed project is 1.2:1. When secondary benefits are not included, the benefit cost ratio is 1.1:1. Table 6 summarizes the benefits and cost of individual or groups of measures included in the plan.

#### PROJECT INSTALLATION

The Lincoln and Yellow Medicine Soil and Water Conservation Districts are the Sponsoring Local Organization and will be responsible for accomplishing this plan. The Lac qui Parle-Yellow Bank Watershed District has been established in accordance with Minnesota State law, and will be the legal entity of government.

After the legal requirements under Minnesota State law have been fulfilled, the watershed district will assume sponsorship responsibilities by signing a supplemental work plan agreement. These legal requirements include filing a petition by the people for the project with the board of managers of the watershed district and establishment of the project as determined at a satisfactory hearing.

The education phase of the program will be promoted by the Soil and Water Conservation Districts, cooperating with the Extension Service, through dissemination of general information to individuals and local groups. They will prepare radio and press releases and use

other means such as tours and demonstrations for acquainting and assisting landowners and operators to understand, and thereby increase participation in carrying out the land treatment and structural measures for flood prevention and erosion control.

The land treatment phase of the program including forestry measures, will be completed by the landowners and operators in the district. Technical assistance for planning applying open land practices will be provided by the Soil Conservation Service and forestry practices by the Minnesota Department of Natural Resources, Division of Lands and Forestry, in cooperation with the U.S. Forest Service. Financial assistance from the Agricultural Stabilization and Conservation Service for the installation of land treatment measures will be utilized when applicable. A 7-year installation period is proposed for this project.

The watershed district's board of managers will be responsible for securing land rights for the proposed structural measures. They will have the power of eminent domain and taxation by law. The watershed district will have the power to control the use of all water within the watershed.

The watershed district will administer the contracts for installation of works of improvement. The contracts will be handled by construction units as outlined in table 7, page 51. After the land rights are cleared on a construction unit, contracts can be let for part or all the structural measures in that unit.

The Director, Minnesota Historical Society, has been notified on the intent of the Sponsoring Local Organization to construct 3 floodwater-retarding reservoirs in accordance with Public Law 86-523. This public law is for the preservation of historical and archeological data. To date, there has not been any evidence of archeological or historical data that would be affected by the works of improvement.

A cultural assessment of Canby Creek Watershed will be conducted prior to beginning construction. The Minnesota Historical Society will be requested to conduct this survey and assessment. If affected cultural resources are encountered, a salvage and/or preservation program will be developed in association with the Sponsoring Local Organization, Soil Conservation Service, Minnesota Historical Society (State Historical Preservation Officer), and U.S. Department of the Interior, National Park Service.

A complete water quality monitoring program will be established to begin about 1 year before construction commences. The program will extend through the construction period and for about 1 year beyond. Samples will be obtained during low flows,



storm flows, and during planting, harvesting, and growing seasons. The Soil Conservation Service and the Sponsoring Local Organization will seek an Environmental Protection Agency and/or State agency grant to obtain necessary funding.

Flood control structures need to be constructed before the installation of the stream channel stabilization measures.

Engineering service including investigations, surveys, design, construction specifications, geologic investigations, and analysis for structural measures except those included under land rights and basic facilities, will be provided by the Soil Conservation Service. Engineering services for the bridges and roads will be the responsibility of the Sponsoring Local Organization and will be paid from other than Public Law 566 funds. Engineering services for the recreational facilities will be handled by an engineering contract administered by the Sponsoring Local Organization. Public Law 566 funds will pay 50 percent of the engineering contract.

The construction of all structural measures in the plan will comply with Federal, State and local regulations concerning air and water pollution.

Public Law 566 project administration includes the cost of administration, review of engineering plans developed by others, construction surveys, government representatives, necessary inspection service during construction and administrative costs to the Sponsoring Local Organization in fulfilling their responsibilities for relocation assistance advisory services. Local project administration costs include administration of contracts, legal fees, clerical, construction inspection they may perform, and relocation assistance advisory service. Included in these advisory services, the watershed district will (1) determine the need for relocation assistance, (2) obtain current information on decent, safe, and sanitary replacement dwellings, business properties and farms, (3) preparation of handout brochure, (4) assure replacement dwellings, and (5) assist in getting established, etc.

There is decent, safe, and sanitary replacement housing available within the area.

Supervision of construction will be provided by the Soil Conservation Service on those items that are cost-shared with Public Law 566 funds.

#### FINANCING PROJECT INSTALLATION

The Lincoln and Yellow Medicine Soil and Water Conservation Districts Board of Supervisors will cooperate with private landowners

and operators in applying the land treatment measures and conservation plans. Technical assistance for open land treatment measures and conservation plans will be continued by the Soil Conservation Service through the existing program with normal operating funds. During the 7-year project installation period, the present program will be accelerated with financial assistance from Public Law 566.

The forestry program will be installed using private and public funds. It is expected to be accelerated through the Public Law 566 program. Technical assistance will be cost-shared between the Forest Service and the Minnesota Department of Natural Resources. Installation of proposed forestry measures will be the landowner's obligation. The Agricultural Stabilization and Conservation Service will provide part of the financial assistance in applying the open and forest land treatment program. The amount of assistance will depend upon Congressional appropriations of funds during the installation period.

The watershed district board of managers will be responsible for the installation of all structural measures. They will award and administer all contracts.

The Federal cost-sharing assistance for the installation of the structural measures including technical and administrative services, will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566 - 83d Congress; 68 Stat. 666) as amended. All federal assistance obtained for Public Law 566 is contingent on Congressional appropriation of the necessary funds.

The watershed district will be responsible for obtaining the other than Public Law 566 monies for the installation of the structural measures and relocation payments. The Sponsoring Local Organization have filed a letter of intent with Farmers Home Administration for a loan to finance these costs which include land for structural measures, utility relocation, and recreational development. The loan and interest will be repaid by payments over a period of years collected by assessments based on benefited areas. It is expected that the road culvert required will be financed by the county and township involved, with their regular funds available for this purpose.

An admission fee will be charged at the entrance of the recreation development for the sole purpose of loan payment, replacement, operation, and maintenance of the development. Fees charged at other facilities of similar quality will be used in the determination of the entrance fee.

The watershed district will need to acquire fee simple title to 615 acres of land for the multiple-purpose structure R-1



recreational development. In addition, a flowage easement will be needed on 55 acres in upper reaches of the site. The district will also acquire flowage easements for the remaining structural measures.

Estimated project installation cost is tabulated in table 1, showing Public Law 566 and other (local) funds.

#### PROVISIONS FOR OPERATIONS AND MAINTENANCE

The landowners and operators are responsible for operation and maintenance of all land treatment measures installed on their lands. Technical assistance is available from the Soil Conservation Service for operation and maintenance. Forest land treatment measures will be maintained by the landowners. Technical assistance will be provided by the Minnesota Department of Natural Resources, Division of Lands and Forestry, in cooperation with the U.S. Forest Service through the Cooperative Forest Management Program.

Operation and maintenance of all structural measures will be the responsibility of the Sponsoring Local Organization. Specific operation and maintenance agreements will be obtained from the Sponsoring Local Organization prior to the execution of the project agreement.

Maintenance required on floodwater-retarding and multiple-purpose structures may include such items as repair of damage from high intensity storms to principal and emergency spillways and earth fills, modify inlet crest to 100-year sediment pool 50 years hence, repair of stilling basins, riprap, removal of debris from the permanent pools that might affect the operation of the structures, repair of rodent damage, reseeding, and mowing the vegetated areas. Channel stabilization maintenance consists of repairing culverts, bridges, and inlets, periodic clean outs; and mowing of the banks, berms, and side slopes of the channel. Mowing will be delayed until after the nesting season to protect ground nesting birds. Grade stabilization structure maintenance may include the repair of earth fill and the structure. The desirable movement of bedload from the lower 2,000 feet of Canby Creek will be maintained.

For the recreational development, operation, and maintenance will be in accordance with the State of Minnesota Standards.

The operation and maintenance agreements will include provisions for annual joint inspections during the first three years after the installation of the structural measures by the Sponsoring Local Organization and the Soil Conservation Service. During this 3-year period, the Sponsoring Local Organization and a designated Service employee will make a joint inspection annually, after unusually severe floods, and after the occurrence of any other unusual conditions which might adversely affect the structural measures. After the 3-year period, the Sponsoring Local Organization will make an annual inspection. The Sponsoring Local Organization will

be responsible to correct any deficiencies found. Annual inspection reports will be made to the designated Service personnel.

The watershed district will obtain the funds for operation and maintenance of the retarding reservoirs, stream channel stabilization measures, bedload source area, and Lake Sylvan outlet, by assessments against individual property and corporation as originally assessed for the improvements in accordance with the applicable Minnesota Statutes. The culvert and bridge maintenance will be provided by the county and township involved from funds appropriated for such purposes.

For the multiple-purpose structure R-1 and the recreational development, the operation and maintenance will be assumed by the watershed district. A complete drawdown of the permanent pool through the water drawdown device will be made only when it is deemed necessary by the Sponsoring Local Organization responsible for the protection and maintenance of the structure.

The water drawdown device will be used to maintain the pool as a high quality recreational fishing area. When improvement of this resource is deemed necessary by the Minnesota Department of Natural Resources, the recreation pool can be lowered a maximum of 5 feet below the planned elevation in late fall for fishery management purposes.

The operation and maintenance cost for the recreational facilities is estimated at \$16,700 which includes \$8,000 for 2 part-time employees for custodial and policing service and 2 lifeguards during the swimming season: \$2,800 for replacement of recreational facilities after their expected life; and \$5,900 for operational services including power, materials, and equipment. An admission fee will be charged at the entrance of the recreation development for the sole purpose of loan payment, replacement, operation, and maintenance of the development. Fees charged at other facilities of similar quality will be used in the determination of the entrance fee.

The estimated operation and maintenance are shown in table 4 by evaluation units, page 48.





TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Canby Creek Watershed, Minnesota

Installation Cost Item	Unit	Number to be Applied Non-Fed. Land	Estimated Costs (Dollars) 1/				Total
			PL 566 Cost		Other Costs		
			Non-Fed. Land		Non-Fed. Land		
			SCS 2/	FS 3/	SCS 2/	FS 3/	
<u>LAND TREATMENT</u>							
Land Areas 2/							
Cropland	Ac.	5,000			132,250		132,250
Pasture land	Ac.	2,500			37,500		37,500
Forestland		110				4,300	4,300
Other (Managed for Wildlife)	Ac.	50			750		750
Technical Assistance		7,660	30,600	1,800	1,500	400	34,300
TOTAL LAND TREATMENT			30,600	1,800	172,000	4,700	209,100
<u>STRUCTURAL MEASURES</u>							
Construction							
Floodwater Retarding Structures	No.	2	265,000				265,000
Multiple Purpose Structures	No.	1	568,400		100,400		668,800
Recreation Facilities	No.	1	102,800		102,800		205,600
Stream Channel Stab. 4/							
(M) 1967	Mi.	0.4	6,200				6,200
(N)	Mi.	0.4	6,300				6,300
Grade Stab. Strs.	No.	2	25,000				25,000
Subtotal Construction			973,700		203,200		1,176,900





TABLE 1 (continued)

Installation Cost Item	Unit	Number to be Applied Non-Fed Land	Estimated Costs (Dollars) <sup>1/</sup>				Total
			PL 566 Cost		Other Costs		
			SCS 3/	FS 3/	Non-Fed. Land	SCS 3/ FS 3/	
Engineering Services			188,500		10,300		198,800
Subtotal Engineering			188,500		10,300		198,800
Relocation Payments			8,400		3,600		12,000
Subtotal Relocation			8,400		3,600		12,000
<u>Project Administration</u>							
Relocation Assistance							
Advisory Service					4,800		4,800
Construction Inspection			93,200		5,300		98,500
Other			80,500		24,200		104,700
Subtotal Administration			173,700		34,300		208,000
<u>Other Costs</u>							
Land Rights			92,000		208,800		300,800
Subtotal Other			92,000		208,800		300,800
TOTAL STRUCTURAL MEASURES			1,436,300		460,200		1,896,500
<hr/>							
TOTAL PROJECT			1,466,900	1,800	632,200	4,700	2,105,600

<sup>1/</sup> Price Base 1971

<sup>2/</sup> Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

<sup>3/</sup> Federal agency responsible for assisting in installation of works of improvement

<sup>4/</sup> Type of channel prior to project (N) - an unmodified well defined channel

(M) Man made ditch or previously modified channel

December 1971



TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT  
(Through 1970)

Canby Creek Watershed, Minnesota

Measures	Unit	Applied to Date	Total Cost <sup>1/</sup> Dollars
<u>LAND TREATMENT</u>			
Brush Control	Ac.	120	1,200
Conservation Cropping	Ac.	2,176	21,760
Contour Farming	Ac.	165	500
Critical Area Planting	Ac.	15	1,500
Crop Residue Management	Ac.	1,051	520
Dam, Multiple Purpose	No.	1	1,250
Diversions	Ft.	8,710	870
Drainage Field Ditch	Ft.	17,010	2,420
Farmstead and Feedlot Windbreak	Ac.	21	5,250
Field Shelterbelt	Ft.	3,300	500
Grassed Waterway	Ac.	43	21,500
Minimum Tillage	Ac.	1,411	700
Mulching	Ac.	219	110
Pasture and Hayland Management	Ac.	227	3,400
Pasture and Hayland Planting	Ac.	65	980
Pond	No.	10	6,150
Rotation - Deferred Grazing	Ac.	73	70
Strip-cropping	Ac.	599	2,100
Terrace	Ft.	3,275	320
Buried Drain	Ft.	1,433	570
Wildlife Wetland Management	Ac.	34	510
Wildlife Habitat Management	Ac.	272	4,080
TOTAL LAND TREATMENT			76,260
<u>STRUCTURAL MEASURES</u>			
None			
TOTAL			76,260

<sup>1/</sup> Price Base 1970

December 1971





TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Canby Creek Watershed, Minnesota

(Dollars) <sup>1/</sup>

Item	Installation Cost P. L. 566 Funds					Installation Cost - Other Funds					Total Install- ation Cost
	Construc- tion	Engin- eering	Relocat. Paymts.	Land Rights	Total P. L. 566	Construc- tion	Engin- eering	Relocat. Paymts.	Land Rights	Total Other	
Floodwater Retarding Structure R-4A Structure R-6 Multiple Purpose Structure R-1 Recreation Facil. Stream Channel Stab. M 6/ N 7/ Grade Stab. Str. Grade Stab. Str. w/road	83,700	23,900			107,600				31,700 <sup>2/</sup>	31,700	139,300
	181,300	34,100	4,200		219,600			1,800	70,500	72,300	291,900
	568,400	114,200	4,200	50,700	737,500	100,400		1,800	53,600	155,800	893,300
	102,800	10,300		41,300	154,400	102,800	10,300		41,300	154,400	308,800
	6,200	1,200			7,400				2,700	2,700	10,100
	6,300	1,300			7,600				9,000 <sup>3/</sup>	9,000	16,600
	12,500	1,750			14,250	(2,000) <sup>4/</sup>					14,250
	12,500	1,750			14,250						14,250
	973,700	188,500	8,400	92,000	1,262,600	203,200	10,300	3,600	208,800	425,900	1,688,500
	Subtotal										
Project Administration					173,700					34,300	208,000
GRAND TOTAL	973,700	188,500	8,400	92,000	1,436,300	203,200	10,300	3,600	208,800	460,200	1,896,500

- 1/ Price Base 1971  
2/ Includes \$6,500 for replacement of road culvert in County Ditch No. 19, located in the NE corner of Sec. 4, Norman TWP.  
3/ Includes \$6,300 for land rights for maintaining the natural stream conditions in the lower reach of Canby Creek  
4/ Non Project cost for road crossing with grade stabilization structure  
5/ Includes \$62,800 for geologic investigations for final design.  
6/ Man Made Ditch  
7/ Unmodified, well defined natural channel  
8/ Includes costs of appraisers fees for relocation payments.

December 1971



TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Canby Creek Watershed, Minnesota

(Dollars)  $\frac{1}{-}$ 

Item	COST ALLOCATION		C O S T   S H A R I N G					
	PURPOSE		P. L. 566			OTHER		
	Flood Prevention	Recreation	Total	Flood Prevention	Recreation	Total	Flood Prevention	Recreation
Floodwater Retarding Structure R-4A	139,300		139,300	107,600		107,600	31,700	
Structure R-6	291,900		291,900	219,600		219,600	72,300	
Multiple Purpose Structure R-1 Recrea. Facil.	555,100	338,200	893,300	550,900	186,600	737,500	4,200	151,600
		308,800	308,800		154,400	154,400		154,400
Stream Channel Stabilization	26,700		26,700	15,000		15,000	11,700	
Grade Stab. Strs.	28,500		28,500	28,500		28,500		
Total	1,041,500	647,000	1,688,500	921,600	341,000	1,262,600	119,900	306,000
								425,900

 $\frac{1}{-}$  Price Base 1971

December 1971



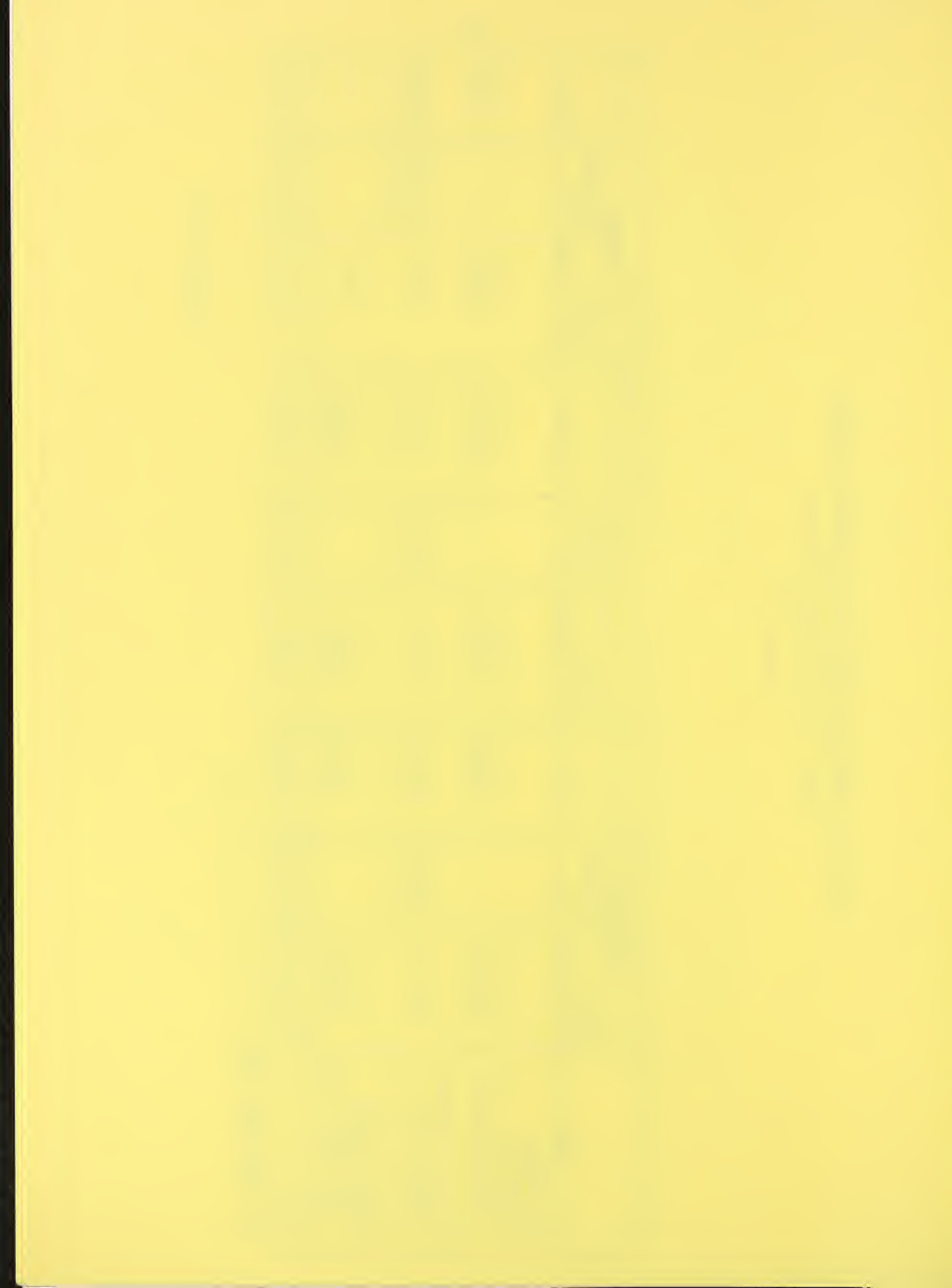


TABLE 2B - RECREATIONAL FACILITIES

ESTIMATED CONSTRUCTION COSTS

Canby Creek Watershed, Minnesota

(Dollars)  $\frac{1}{2}$

Item	Number $\frac{2}{2}$	Estimated Unit Cost	Total Construction Cost
General			
Access Road (2 land paved)	10,000 Ft.	6.00	60,000
Sewer Lines	13,200 Ft.	1.00	13,200
Water Supply	13,200 Ft.	1.00	13,200
Grass Seeding	250 Ac.	50.00	12,500
Tree Planting	50 Ac.	100.00	5,000
Signs	10	50.00	500
Foot Trails	12,000 Ft.	0.50	6,000
Power Lines (Includes light fixtures & outlets)	2,500 Ft.	4.00	10,000
Fencing (Three strand barb wire)	24,000 Ft.	0.20	4,800
Boat Launch Area			
Boat Ramp (Single lane)	1	3,000.00	3,000
Parking Area (30 stalls)	30	31.00	930
Toilets (Vault)	2	500.00	1,000
Launching Dock (Removable type)	1	1,000.00	1,000
Garbage Station	1	50.00	50
Picnic Area			
Tables	40	40.00	1,600
Grills	20	20.00	400
Toilets (Flush)	4	1,250.00	5,000
Shelters	4	1,500.00	6,000
Parking Area (50 Stalls)	50	18.50	925
Landscape Planting	40	15.00	600
Garbage Station	20	50.00	1,000
Playground Equipment (swings, slides, etc.)			2,000
Swimming Beach			
Parking Area (50 Stalls)	50	18.50	925
Bath House (Includes showers, toilets)	1	15,000.00	15,000
Sand Beach	16,500 Sq. Ft.		3,060
Life Guard Station	2	100.00	200



TABLE 2B - RECREATIONAL FACILITIES (cont.)

ESTIMATED CONSTRUCTION COSTS

Canby Creek Watershed, Minnesota

(Dollars) <sup>1/</sup>

Item	Number <sup>2/</sup>	Estimated Unit Cost	Total Construction Cost
Campground (30 Units)			
Picnic Tables	30	40.00	1,200
Grills	30	20.00	600
Toilets (Flush)	8	1,250.00	10,000
Showers	6	200.00	1,200
Playground Equipment (Swings, slides, etc.)			1,500
Fishing Access			
Parking Area (20 Stalls)	20		750
Toilets (Vault)	2	500.00	1,000
			<hr/> 183,600
Contingencies			22,000
Grand Total			205,600

<sup>1/</sup> Price Base 1971

<sup>2/</sup> Estimated quantity subject to minor variation at time of detailed planning

December 1971





TABLE 3 - STRUCTURE DATA  
STRUCTURES WITH PLANNED STORAGE CAPACITY

Canby Creek Watershed, Minnesota

Item	Unit	R-6 $\frac{1}{C}$	R-1 $\frac{1}{C}$	R-4A	Total
Class of Structure		C	C	C	
Drainage Area	Sq. Mi.	15.46	10.37	2.36	28.19
Controlled	Sq. Mi.		15.46		
Curve No. (1day) (AMCII)		75	72	77	
T <sub>c</sub>	Hrs.	6.8	4.1	1.5	
Elevation Top of Dam	Ft.	1489	1303	1323	
Elevation Crest Emergency Spillway	Ft.	1481	1297	1317	
Elevation Crest Principal Spillway Inlet <sup>2/</sup>	Ft.	1448	1287	1303	
Maximum Height of Dam	Ft.	61	56	39	
Volume of Fill	Cu. Yds.	151,500	569,000	75,300	795,800
Total Capacity	Ac. Ft.	2597	4005	505	7,107
Sediment submerged 1st 50 years	Ac. Ft.	-	462	102	564
Sediment submerged 2nd 50 years	Ac. Ft.	-	432	90	522
Sediment aerated - 100 years	Ac. Ft.	313 <sup>3/</sup>	-	-	313
Sediment - Recreation Pool	Ac. Ft.	-	78	-	78
Sediment aerated - Retarding Pool	Ac. Ft.	78	54	24	156
Recreation Pool	Ac. Ft.	-	1,203	-	1,203
Retarding	Ac. Ft.	2,206	1,776	289	4,271

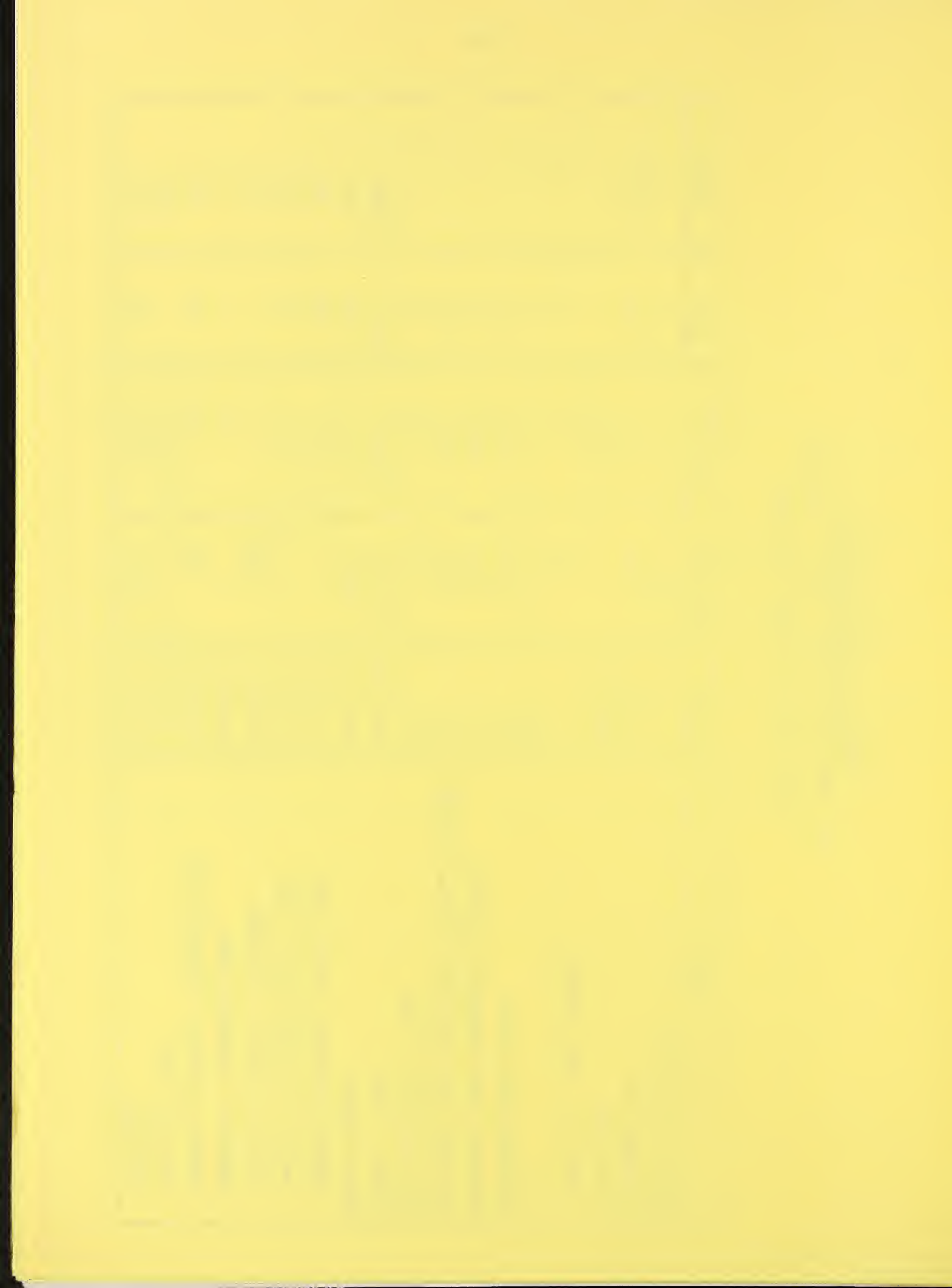


TABLE 3 (continued)

Item	Unit	R-6 $\frac{1}{\text{in}}$	R-1 $\frac{1}{\text{in}}$	R-4A	Total
Surface Area					
Sediment Pool	Acres	37 <sup>3</sup> / <sub>4</sub>	89	22	148
Recreation Pool	Acres	-	147	-	147
Retarding Pool	Acres	130	217	62	409
Principal Spillway					
Rainfall Volume (areal) (1 day)	Inches	5.62	5.73	5.73	
Rainfall Volume (areal) (10 day)	Inches	9.61	9.70	9.70	
Runoff Volume (10 day)	Inches	4.35	3.80 <sup>1</sup> / <sub>4</sub>	4.80	
Capacity of Principal Spillway (Max.)	cfs	274	386	115	
Frequency Operation Emergency Spillway	% chance	1	1	1	
Diameter of Conduit	Inches	42	48	30	
Emergency Spillway					
Rainfall Volume (ESH)(areal)	Inches	9.27	9.25	9.25	
Runoff Volume (ESH)	Inches	6.20	5.80	6.46	
Type		Vegetated	Vegetated	Vegetated	
Bottom Width	Ft.	500	600	260	
Velocity of Flow (Ve.) Emerg. Hydro	Ft./Sec.	7.43	5.78	5.75	
Slope of exit channel	Ft./Sec.	0.03	0.03	0.03	
Maximum Water Surface Elevation	Ft.	1,485	1,299	1,320	





TABLE 3 (continued)

Item	Unit	R-6 <sup>1/</sup>	R-1 <sup>1/</sup>	R-4A	Total
Freeboard					
Rainfall Volume (FH)(areal)	Inches	23.35	23.30	23.30	
Runoff Volume (FH)	Inches	19.78	19.20 <sup>4/</sup>	20.10	
Maximum Water Surface Elevation	Ft.	1,489	1,303	1,323	
Capacity Equivalents					
Sediment Volume	Inches	0.47	1.85 <sup>4/</sup>	1.71	
Retarding Volume	Inches	2.68	3.21 <sup>4/</sup>	2.30	

1/ Structure R-6 and R-1 are in series

2/ Principal Spillway crest will be raised to 100 year sediment pool at end of 50 years, 1309 Ft. for R-4A  
1452 Ft. for R-6

3/ Structure designed with drawdown features to provide a dry dam.

4/ Based on uncontrolled area for R-1

December 1971



TABLE 3A - STRUCTURE DATA

## CHANNELS

Canby Creek Watershed, Minnesota

Channel Designation	Station 100 Ft.	Drainage Area 3/ Sq. Mi.	Capacity cfs		Water Surface Elev. (Ave.)	Hydraulic Gradient Ft./Ft.	Channel Dimensions		
			Req'd	Design			Bottom Ft.	Depth Ft.	Side Slopes
Canby Creek Main	279 to 292	1.2	470	472	1200.3	0.0002	32	8.0	2:1
	292 to 295	1.2	470	472	1200.4	0.0002	32	8.0	2:1
	295	Grade Stabilization Structure							
	295 to 313+00	1.17	470	466	1205.7	0.0002	35	8.0	2:1
	313 to 319+00	1.17	470	466	1205.8	0.0002	35	8.0	2:1
320	Grade Stabilization Structure								
	319 to 321	1.0	457	459	1213.4	0.0001	35	4.0	2:1
Channel Designation	Station 100 Ft.	"n" Value		Velocities		Excav. Cu. Yds. 1000 C.Y.	Type of Work	Type of Channel Before Proj.	Flow 2/ Conditions Before Proj.
		Aged	As Built	Aged	As Built				
Canby Creek	279 to 292	0.035	0.025	1.67	2.04	1.10	V 4/	M (1967)	Pr
	292 to 295	0.035	0.025	1.67	2.04	0.69	V 4/	N	Pr
	295	Grade Stabilization Structure							
	295 to 313	0.035	0.025	1.65	2.00	25.8	V 4/	N	Pr
	313 to 319	0.035	0.025	1.65	2.00	9.2	V 4/	M (1967)	Pr
320	Grade Stabilization Structure								
	319 to 321	5/	5/	5/	5/	0.4	V 4/	M (1967)	Pr

1/ M ( ) Man made ditch (construction date) N Unmodified, well defined natural channel.

2/ Pr Perennial - Flows at all times except during extreme drought.

3/ Uncontrolled area.

4/ Stabilization as primary purpose.

5/ This short reach will be mostly rip rap inlet area to structure.



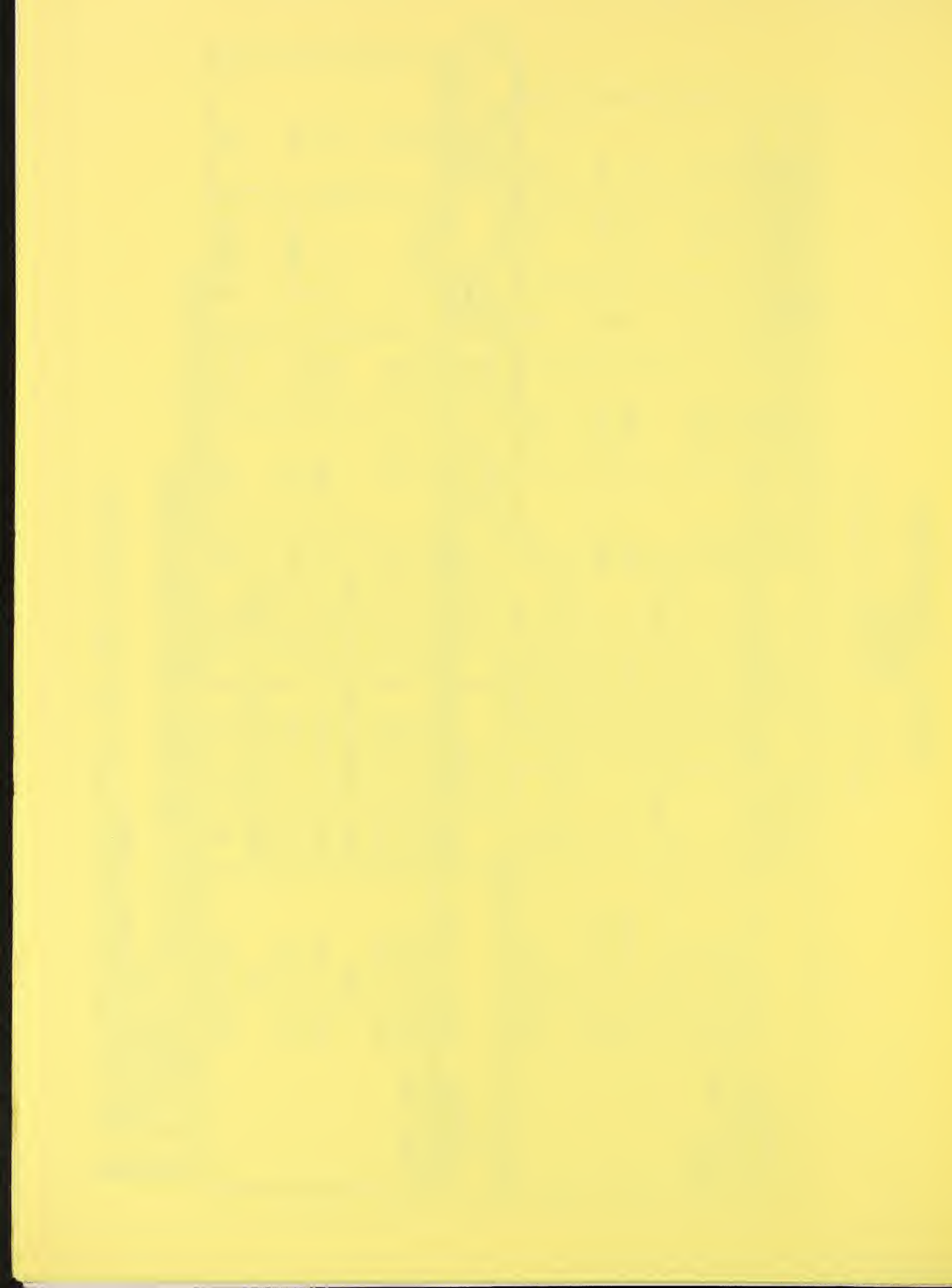


TABLE 3B - STRUCTURE DATA  
GRADE STABILIZATION STRUCTURES  
Canby Creek Watershed, Minnesota

Site No.	Drainage <sup>1/</sup> Area (Sq. Mi.)	Drop (Feet)	Concrete (Cu. Yds.)	Type of Structure
<u>Stream Channel Stabilization</u>				
Sta. 295(w/road)	1.17	5	20.0	BI & C <sup>2/</sup>
Sta. 320	1.00	9	26	BI & C

<sup>1/</sup> Uncontrolled Area below R-1

<sup>2/</sup> BI & C = Box Inlet and Culvert

December 1971



TABLE 4 - ANNUAL COST  
Canby Creek Watershed, Minnesota  
(Dollars) <sup>1/</sup>

Evaluation Unit	Amortization of Installation Cost <sup>2/</sup>	Operation and Maintenance Cost	Total Cost
Floodwater Retarding Structure R-4A	7,530	300	7,830
Floodwater Retarding Structure R-6, Multiple Purpose Structure R-1, Recreation Facilities, Stream Channel Stab., and Grade Stab. Strs.	83,720	20,770 <sup>3/</sup>	104,490
Project Administration	11,240		11,240
GRAND TOTAL	102,490	21,070	123,560

<sup>1/</sup> Price Base, Installation - 1971, O&M Adjusted Normalized

<sup>2/</sup> Amortized for 100 years at 5 3/8 percent interest

<sup>3/</sup> Includes \$16,700 for operation, maintenance and replacement for the recreation development.

December 1971





TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Canby Creek Watershed, Minnesota

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	790	100	690
Crop (Off Project) <u>2/</u>	72,690	61,650	11,040
Other Agricultural	210	20	190
Other (Off Project)	13,440	10,200	3,240
Non Agricultural			
Business Properties			
Canby Creek	7,350		7,350
Residences, Canby Cr.	5,350		5,350
Residences, C. D. No.19	7,800	1,530	6,270
Property Values	<u>7,160</u>		<u>7,160</u>
Urban Subtotal	27,660	1,530	26,130
Road and Bridge	3,480	300	3,180
Road (Off Project)	<u>3,070</u>	<u>1,080</u>	<u>1,990</u>
Subtotal	32,140	1,950	30,190
Subtotal (Off Project)	89,200	72,930	16,270
Indirect	4,780	290	4,490
Indirect (Off Project)	9,070	7,350	1,720
TOTAL (In Project)	36,920	2,240	34,680
TOTAL (Off Project)	<u>98,270</u>	<u>80,280</u>	<u>17,990</u>
	135,190	82,520	52,670

1/ Price Base - Adjusted Normalized

2/ Damages and benefits evaluated outside watershed boundaries

December 1971



TABLE 6 - COMPARISON OF BENEFITS AND COST FOR STRUCTURAL MEASURES

Canby Creek Watershed, Minnesota

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS <sup>1/</sup>					Total Benefits	Average Annual Cost	Benefit Cost Ratio
	Damage Reduction	More Intensive Land Use	Urban Area Enhancement	Recreation	Secondary			
Floodwater Retarding Structure R-4A	12,100	570			1,210	13,880	7,830	1.8:1
Floodwater Retarding Structure R-6, Multiple Purpose Structure R-1, Recreation Facilities, Stream Channel Stabilization and Grade Stab. Strs.	37,900	5,680	3,170	71,700	14,170	132,620	104,490	1.3:1
Project Administration							11,240	
GRAND TOTAL	50,000 <sup>2/</sup>	6,250	3,170	71,700	15,380	146,500	123,560	1.2:1

<sup>1/</sup> Price Base - Adjusted Normalized

<sup>2/</sup> From Table 4

<sup>3/</sup> In addition, land treatment measures are estimated to provide flood damage reduction benefits of \$2,670 annually.



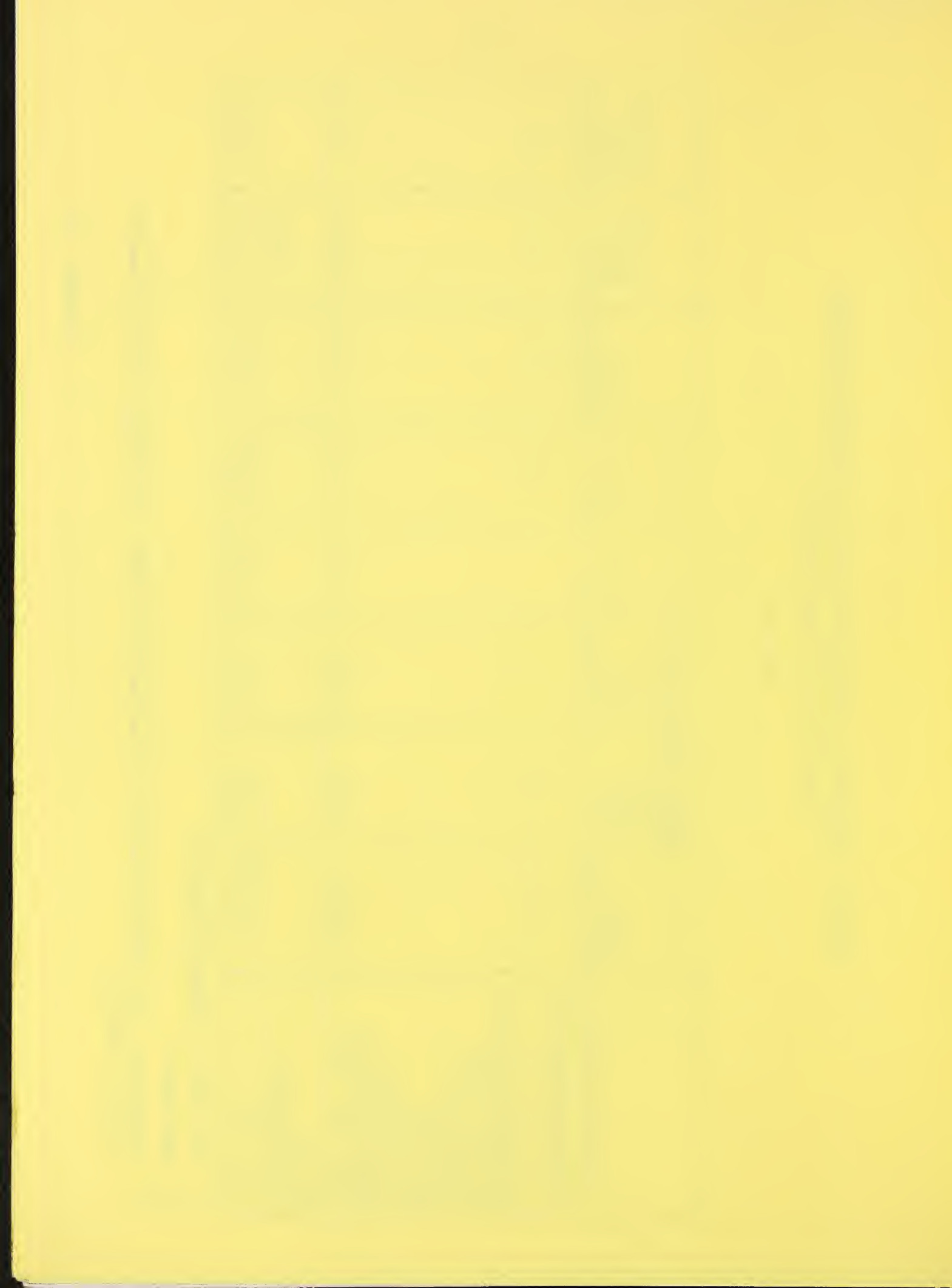


TABLE 7 - CONSTRUCTION UNITS  
Canby Creek Watershed, Minnesota  
(Dollars) <sup>1/</sup>

Measures in Construction Unit	Annual Benefit	Annual Cost
1. Floodwater Retarding Structure R-6, Multiple-Purpose Structure R-1, Recreation Facilities, Stream Channel Stab., Grade Stabilization Strs.	132,620	114,960
2. Floodwater Retarding Structure R-4A	13,880	8,600

<sup>1/</sup> Price Base, construction costs, 1971 prices. Benefits and Operation, Maintenance and Replacement, Adjusted Normalized.

December 1971

## INVESTIGATIONS AND ANALYSES

### Hydraulic and Hydrologic Investigations

The following physical data and procedures were used to develop hydrographs for the design of structural measures and to determine their effect on reducing floodwater damages. The procedures used, if not referenced, are described in the Soil Conservation Service National Engineering Handbook, Section 4, Hydrology.

#### Hydraulic Studies

Stage-discharge relationships (rating curves) were developed to determine floodwater damages and for use in flood routing. Thirty-seven valley cross-sections were surveyed approximately every one-fourth mile on Canby Creek and county ditch No. 19. The channel cross-sections were superimposed with flood plain elevations plotted from low level aerial photographs by a stereo plotter to obtain complete valley cross-sections. Sixteen additional valley cross-sections were surveyed in the field. Field survey data was obtained for roads and bridges and high water marks on the flood plain.

Rating curves for Canby Creek and county ditch No. 19 were developed by using the valley cross-sections and Mannings Formula to plot water surface profiles for selected discharges. Rating curves for the Miller Group Ditch were developed by using Manning Formula and the channel slope at isolated cross-sections.

The effect of bridges and culverts was determined in plotting water surface profiles for county ditch No. 19 and for Canby Creek in the reach through Canby. A 2 foot interval stereo plotted contour map was developed adjacent to Canby Creek in the city of Canby to assist in determining damages.

Stage-area flooded curves were developed for 17 valley reaches on Canby Creek, 4 reaches on county ditch No. 19, and 12 reaches on the Miller Group Ditch. Area flooded by depth increments of 0-1 foot, 1-3 feet, and greater than 3 feet were used to evaluate damages.

Stage-area flooded - duration data was developed for 9 hydrologic valley reaches on the lake plain between the outlet of Canby Creek and the junction with the Lac qui Parle River.

Stage-damage was determined at several points in the city of Canby and at roads and bridges.

#### Hydrologic Studies

Rainfall-runoff relationships were used as a basis for project evaluation and for the design of structural measures.

United States Weather Bureau Technical Papers No. 40 and 49 were used to develop rainfall-frequency curves for the watershed. Twenty-four hour partial duration series rainfall depths were used for evaluation of the project.

Runoff depths that occur from various rainfall depths were determined from runoff curve numbers. Runoff curve numbers were determined by taking a 5 percent random sample of quarter sections. Runoff curve numbers were developed for four major land resources in the watershed for present conditions and for projected future conditions.

Runoff depths from snowmelt were determined by developing snowmelt runoff frequency curves for the stream gage on the Lac qui Parle River near Lac qui Parle. The Log Pearson Type III Frequency Method was used to analyze 19 years of record.

Runoff-discharge relationships were determined by using the Computer Program: Project Formulation Program, Hydrology.

Routings were made using a time increment of 0.2 hour and 24 hour duration. Standard Type I storm distribution was used for present conditions and with project conditions. The resultant data were used for project evaluations. Additional routings with 0.5 hour time increment were made to determine effects of duration flow on the flood plain below Canby Creek and to evaluate incremental effects of the two construction units.

Watershed boundaries were determined from advanced copies of 7½ minute U.S.G.S. topographic maps with 10 foot contour intervals. Stereo-plotted topographic maps from low level aerial photos were used to assist in determining boundaries. The watershed was divided into sub-watersheds for the development of hydrographs and flood routing. Lazarus Creek and additional subwatershed areas were included in the routings to evaluate the effects of the project below the Canby Creek outlet.

Bankfull velocities estimated from the slope and other characteristics of the channel were used to estimate time of concentration and travel time where rates cross-sections were not available.

Eight partial duration series floods ranging from the 1 percent chance to the 300 percent chance were routed through the watershed under present conditions and with project conditions. The 100-year frequency flood elevations were compared with known high water marks on the flood plain. The area flooded for the various frequencies was correlated with field interviews conducted by the economist.



Discharges from snowmelt runoff were obtained by assuming a direct relationship between discharge and runoff volume. Snowmelt runoff discharges were computed from the rainfall runoff discharges (developed by the TR-20 Computer Program) by using the ratio of their respective volumes of runoff. Snowmelt floods, in addition to rainfall floods, were used to evaluate urban, road, and bridge damages.

#### Multiple-Purpose and Floodwater Retarding Structure Design Hydrologic Criteria

The hydrologic procedures contained in Chapter 21<sup>1/</sup> were used for structure design.

Hydrographs for the design of the principal spillway for structures R-1, R-6, and R-4A were based on the 100 year - 1 day duration and the 100 year - 10 day duration rainfall depths obtained from the U.S. Weather Bureau TP-40 and TP-49. Snowmelt runoff at the rate of 6 csm was included in the principal spillway hydrographs. Snowmelt runoff was assumed to be the only inflow during the 10 day principal spillway drawdown requirement.

Design storm rainfall depth for the development of the emergency spillway and freeboard hydrographs were obtained from rainfall charts in Chapter 21. The rainfall depths used for the design hydrographs are shown in table 3 of the plan.

A reservoir operation study was made to determine if an adequate supply of water is available for the recreation pool above structure R-1. This study was made using the computer program "Reservoir Operation Study" developed for the IBM 1130 Computer.

Monthly runoff depths used for the reservoir operation study were determined from the U.S.G.S. stream gage on the Lac qui Parle River near Lac qui Parle. Monthly rainfall depths were taken from the U.S. Weather Bureau rain gage at Canby. Evaporation rates were determined from U.S. Weather Bureau Bulletin No. 37. Seepage rates through the dam and reservoir rim were determined by the geologist.

Studies were made of the embankment and foundation materials to estimate seepage through the structure. Water table levels were determined from wells in the area to estimate seepage from the reservoir rim.

Rainfall and runoff data collected for the reservoir study covered the period from 1935 to 1967.

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<sup>1/</sup> SCS National Engineering Handbook, Section 4, Hydrology.

### Stream Channel Stabilization Design Hydrologic Criteria

Discharge frequencies developed from the 24 hour duration storm used for project evaluation were used for stream channel stabilization and the design of grade stabilization structures. For grassed floodways, a 5-year frequency peak discharge was used for design capacity. A 50-year frequency discharge was used for the design of culverts and bridges associated with the floodways. The 100-year frequency discharge (with project conditions) was used for design of the stream channel stabilization structures, and required culvert and bridge capacities within the city of Canby.

Velocities with improved channel conditions were used with project for reach routing.

### Land Use Treatment

The cropland soils in the watershed with water erosion hazards include about 9,170 acres out of the total cropland acreage 12,400. From this acreage, an average estimate of 105,000 tons of soil are presently eroded annually. At the end of the project installation period, the applied land treatment will reduce the total soil loss by 50 percent or by an average of 52,400 tons of soil annually.

With the project, the acreage of land with less than four tons of soil loss annually per acre will increase from 1,250 acres to 6,350 acres. The acreage of land with soil losses between four and eight tons will be reduced from 3,700 to 800 acres. Also with the project, the acreage of land with soil losses over eight tons per acre per year will be reduced from 4,400 to 2,200 acres.

Present land treatment adequacy and future land treatment needs were estimated by selecting a 5 percent random sample of quarter sections in each of four major land resource areas within the watershed. These sample areas were studied to determine land use by the various land capability units and expanded to cover the entire watershed. In consultation with local soil conservation personnel, an adequate land treatment program was established for each land capability class and land use. The sum of these practices determined the total amount of soil and water conservation practices needed to adequately protect and improve the soil resources on the watershed. The amount of applied practices was obtained from Soil Conservation Service Work Unit records. The amount of practices to be applied in the project period was determined from the expected participation by the landowners and operators and the remaining job to be done. The needed practices were expressed as acres to be adequately treated considering the alternative practices which could be used to protect the various land capability classes. Soil loss was based on the Universal Soil Loss Equation.



The Forest Service made a study of the watershed to determine the forestry needs. Forest land treatment costs are shown in table 1.

### Economics

Farmers operating land in the flood plain and businessmen and homeowners located in the flood plain of Canby Creek and the downstream flood plain were selected at random to be interviewed regarding damages from floodwater. About 50 percent of the total individuals affected by floods within the watershed were interviewed. From the farmers the following information was obtained: Flood-free yields from flood plain land; land use and cropping pattern of flood plain land; usual production practices; area flooded patterns; and losses sustained to crops, pastures, fences, and other agricultural assets when flooding occurs. Interviews with businessmen and homeowners provided the following information: Damages in homes and businesses from floods, length of time business was inoperative, and cleanup costs.

### Floodwater Damage Reduction

Average annual acres flooded was developed for both without and with project conditions. A composite acre of cropland and pasture was developed for each reach. Damage factors expressed as a percent damage of the gross value of the crop were developed by reaches for each growing season month and for three flooding depth increments; 0 to 1 foot depth, 1 to 3 feet depth, and over 3 feet depth. These factors converted the physical flooded acreage into a monetary value. Other agricultural damages were determined from interviews and converted into a damage value per flooded acre for each of the three flooding depth increments. Damages to roads and bridges were obtained from county and township officials and by estimating the damages that occur from various depths of water over bankfull for each bridge and section of road damaged from floodwaters. Economics II "Floodwater Damages" Computer Program was used in converting the floodwater damage reduction benefits into an average annual value.

Flood duration studies were conducted of the flood plain between the outlet of Canby Creek and the junction of the Lac qui Parle River. This evaluation determined the extent of flooded areas resulting from prolonged flows from the floodwater-retarding structures as well as the reduction of peak flows with the retarding structures. Crop and pasture damage factors were developed for each growing season month and for six duration increments; on to six days of flooding respectively. These values were applied to the calculated acres flooded by duration increments.

Economic evaluations were not made of the effect of structure R-6 on the flood plain above R-1. Limited flood damage occurs in this reach due to the large channel capacity, narrow flood plain, and the existing land use which is mostly grassland.

Urban damages were obtained from interviews within the city of Canby and with the use of the Residence Flood Damage Table with some adjustment. An estimate was made of the damages to occur from various depths of water over bankfull for each damaged property. Depth of water over bankfull for each frequency for without and with project conditions provided the basis for converting the damages into an average annual value. Urban damages were adjusted to reflect future changes expected from increased labor costs and standard of living. Projected personal income in Planning Area No. 16 in the Upper Mississippi River Basin was used as a measure of the future condition.

#### Indirect Damages

The indirect damages are associated with the floodwater damages. They represent the inconvenience and unevaluated costs which accompany these damages. They are calculated as 10 percent of the average annual agricultural damages and 15 percent of the average annual urban, road, and bridge damages for both with project and without project.

#### Land Enhancement Benefits

Cropland areas to be farmed more intensively were determined from a visual observation in the field and of photos as well as from interview data for those fields most likely to be benefited. Fields were outlined which have frequent flooding from both the main channels and from overflows upstream. Benefited areas were outlined by existing fields rather than parts of fields for the cropping systems are usually uniform within a field. Fields are generally large in size in this watershed.

Increased property value benefits were developed with the assistance of a local realtor who provided an estimate of the increased property value for each residence and business property to be benefited with the flood control project. The total increased valuation was amortized to obtain annual benefits.

#### Recreational Benefits

The benefits to the recreational development incorporated in R-1 multiple-purpose structure were evaluated in terms of visitor day use. The recreational facilities will have a capacity for 200 visitors in the picnic area, 200 in the beach area, 120 in the campgrounds, 45 in the boat launching area, and 32 in the fishing access area. The total expected annual visitor day usage of the recreational facilities is 47,800. These are valued at \$1.50 per visitor day and results in \$71,700 of recreation benefits expected annually from the facilities.



A study of the opportunity demand of various recreational activities for the site produced a numerical value of 136,341 demand activities. Assuming that the average visitor will participate in 2.5 activities, the recreational demand is equal to 54,536 visitor days. It is assumed, based on this study, that the existing demand for recreational activities is equal to or greater than that which the facilities will provide.

#### Secondary Benefits

Installation of project measures in this watershed will result in increased income to processors of agricultural products to business establishments in towns and trade areas affected, and to individuals other than the direct identifiable beneficiaries. These benefits were determined to be 10 percent of the following: Direct primary benefits, increased cost of more intensive land use, and of the operation and maintenance costs. These benefits were not used for economic justification, but were included in the final benefit-cost analysis.

#### Price Base for Benefits and Costs

Prices received by farmers are "adjusted normalized prices" obtained from the Interim Price Standards for Planning and Evaluating Water and Land Resources, Inter-Departmental Staff Committee of the Water Resource Council, dated April 1966. Prices paid by farmers and the operation and maintenance cost of structural measures are based on 1971 prices converted to adjusted normalized prices.

Installation costs were calculated on the current 1971 price base.

The value of land rights used for cost estimating are based upon the values set by appraisers on similar land areas in this area of the state.

In converting project costs to an annual basis, a 5-3/8 percent interest rate for the 100-year project period was used. In converting private associated costs to an annual basis, a 6 percent interest rate was used.

#### Basis of Cost Allocation to Purpose

The multiple-purpose structure was allocated to purpose by the "Use of Facilities Method" as explained in Chapter 10 of the Economics Guide. A total of 2,802 acre feet of storage is provided for flood control and sediment, and 1,203 acre feet for recreation. The joint cost of the structure is, therefore, allocated 70 percent to flood control and 30 percent to recreation.

The remaining structures and stabilization measure are single-purpose flood control measures.

### Geologic Investigations - General

All flood control and recreation sites proposed in this work plan were investigated with sufficient intensity to determine the geologic feasibility of the sites. Geologic reports are on file for all sites.

### Geologic Investigations - Site R-1

Two general sites were originally proposed for the large structure on Canby Creek. Geologic investigations were made on two sites, R-1 and R-2. Site R-1 was chosen over site R-2 because site R-1 is closer to the damage areas. Therefore, the degree of damage reduction would be greater. Geologic conditions at both sites are similar.

Three dam axes were drilled on site R-1. The lower two axes were abandoned after it was determined that adverse geologic foundation conditions would be very expensive to overcome. The final axis also provided greater structure safety.

The overburden and bedrock deposits along the centerline of the dam were delineated into zones having generally similar engineering characteristics and common geologic origins. The numerical values for shear strength, consolidation, permeability, and dry in-place density are estimates based on standard penetration tests, open-end permeability test, laboratory sand sieve tests, and from laboratory tests performed on samples from other projects. Gypsum may exist in the lake clay foundation deposits as scattered crystals. Additional geologic investigations for final structure design will need to be made.

Permanent water storage at this site is geologically feasible.

### Range of Permissible Data Extrapolation

Extrapolation of foundation conditions beyond the dam axis actually investigated is not recommended at this site. The recommendation is based on the complex geology, nature of the foundation defects, and the high hazard structure class.

### Effect of Site on Groundwater Table

An attempt was made to correlate the sand and gravel layers from site R-1 to the city of Canby. No individual aquifer could be traced the entire distance. Storing water over this sand aquifer will increase the rate of recharge but it will have no significant effect on the water table in Canby.

### Recreation Facilities

1. Local on-site sources of suitable beach sand and gravel are available but have not been located.
2. Excellent glacial sand and gravel aquifers underlie the entire site. The deeper aquifers will supply adequate potable water for recreation purposes such as drinking water, showers, etc. These deeper aquifers are protected from surface pollution.
3. All ground water movement is from the abutment and reservoir rim towards the recreation pool. Any discharge of effluent into the reservoir rim area will not pollute the deeper sand and gravel aquifers referred to in well development.

### Structure Sediment Storage Requirements

The three structures contained in this plan, R-1, R-4A, and R-6 are located at the base of a uniformly sloping escarpment known as the Coteau des Prairie Front. The Coteau des Prairie Front is a prominent geologic and topographic feature located in southwest Minnesota and eastern South Dakota.

Reliable measurements of sediment yields from the Coteau des Prairie Front is not available to assist in establishing sediment storage requirements. The sediment storage requirements for these structures was determined by extrapolating sediment yields determined from soil loss calculations employing the Universal Soil Loss Equation. The soil losses was calculated using approximately a 5 percent random sample of quarter section in the watershed. A delivery ratio was applied to the gross erosion soil losses to determine sediment yields to the structure.

Average present soil losses of cropland on the Coteau des Prairie Front are estimated at 16 tons per acre annually.

### Channel Stability Investigations

The channel and legal ditch systems below the proposed flood control structures were investigated. Borings were made to secure samples of bank and channel bottom materials. Laboratory sieve and Atterberg tests were made on the materials and non-scour velocities were determined for each sample by the procedure outlined in SCS Technical Release No. 25. The data was plotted on channel profiles and channel stability was analyzed for without project and for with project conditions for the channel reaches investigated. The geologic report "Floodway Channel Stability Investigations" presents the available data and conclusions.



The preliminary investigation of channel conditions in county ditch No. 8 revealed that the steep gradients, erosive geologic materials, and high channel velocities encountered should produce channel degradation. An investigation of the hydraulic and sediment regime was made for this channel reach to account for the relative stability of this system under such adverse conditions and to predict changes that could be expected in the channel regime with the installation of the proposed project. These investigations indicated that erosion of coarse gravels in the natural meandered reach of Canby Creek immediately above county ditch No. 8 is the source of the materials that is armouring and stabilizing the erosive reach of county ditch No. 8.

### Engineering

A bench level circuit was completed in the channel and structure areas which were closed within the allowable error of third-order leveling. The survey is based on mean sea level datum. Stadia profile surveys were made on the channels with channel cross-sections approximately every one-fourth mile. If channel irregularity demanded, cross-sections were taken at closer intervals. Dimensional data was obtained for all culverts and bridges and other items such as utilities, farmsteads, etc., pertinent to planning. Field surveys were made for the photo points, scales, and elevations necessary for map production. This was completed for all retarding structures and surrounding areas. A topographic map was made of the flood plain in Canby.

### Canby Creek Subwatershed

The local people suggested locations of potential structure sites above Canby, immediately above the major damaged areas. They also indicated their preferred recreation site. From the description of the sites below, they can be located on the project map.

Three sites were studied in varying degrees on Canby Creek in developing the Preliminary Investigation Report. The upper site, R-3 located on the east side of section 18, T. 114 N., R. 45 W., was eliminated first because it was only one-half mile above the R-2 site located in the NE $\frac{1}{4}$  of section 17. Topographically, R-2 was the better site in that it would be nearer to the benefited area and was the preferred recreational site. Therefore, R-3 was eliminated and R-2 was considered for further study.

Another site, R-1, located in the center of section 9 about one-half mile upstream from Canby, was investigated. This site was studied because of its location immediately above Canby and it would control several square miles more than R-2. The topography of the site is not as good as R-2. The best location would have been a few hundred feet downstream, but the foundation conditions are unfavorable. The material is glacial outwash, coarse cobbly gravel,



and sandy gravels with a 2 to 5 foot layer of ground moraine glacial till about 10 feet below the valley floor. The pervious glacial outwash extends down about 50 feet with the water table depth at about 7 feet. The treatment of this foundation to provide a recreational reservoir would be very costly. Therefore, the geologist investigated further upstream to the present site and found the glacial till was thicker and allowed a more reasonable foundation cost. This glacial till is overlaid by about 6 feet of surficial glacial outwash and is underlaid by glacial lake beds of clay and fine sand.

The foundation material for R-2 is also glacial outwash similar to R-1, but it is only about 20 feet deep with the water table depth at about 6 feet, and is underlain by CL glacial till.

Comparison studies were conducted of R-1 and R-2 to determine which structure would be the most beneficial and the least costly. Each structure was studied for multiple-purpose floodwater-retarding and recreation with a single stage and two stage principal spillways. The outflow peak from the structures and the uncontrolled peak coincided in downstream routing when using the single stage spillway. Therefore, an attempt was made to have the uncontrolled peak pass first by delaying the outflow peak with a low stage orifice in the riser. The low stage was not designed for any given frequency because of the 100-year frequency flood is controlled by the conduit in the principal spillway. It was determined from these routings that the single stage would provide approximately the same protection as the two stage inlet. A lower dam and a more economical structure was obtained with the single stage inlet. The embankment material for both structures is glacial till (CL).

Proposed structure R-1 was determined to be the most economical and most convenient recreational site because of the closeness to Canby. This structure will control the 100-year frequency flood without channel improvement in the urban area. However, stream channel stabilization measures will be required on Canby Creek within the city. The R-2 structure left a larger area uncontrolled and required a large amount of channel and bridge improvement as well as utility changes in Canby to provide protection for a 100-year frequency flood. The R-2 site with the channel improvement cost approximately 30 percent more for total installation than R-1.

The multiple-purpose R-1 reservoir was an expensive structure due to its large earth embankment. It was decided to investigate for a possible retarding site several miles upstream to operate in series with R-1 and thereby reduce the size of the earth embankment of R-1.

A site upstream approximately 4 miles was located, well suited to reducing embankment costs for R-1. The dam site was narrow and the reservoir area wide. This site is located on the project map as R-6. Its geographic location is near the east  $\frac{1}{4}$  corner of section 14, T. 114 N., R. 46 W. Since R-6 has a narrow embankment

side and wide reservoir area, whereas R-1 has a wide embankment site but does have a good reservoir site, it was possible to reduce the volume of earth embankment of R-1 and R-6 in series compared to R-1 alone and produce a substantial saving. The combination of R-1 and R-6 will cost about 10 percent less than R-1 alone.

The channel in Canby is unstable and stream channel stabilization measures including grade stabilization structures were studied to remedy this problem. Limited erosion is taking place in the present channel and it is anticipated that the problem would increase with structure R-1 without the stabilizers. The water will flow with less sediment and for a longer duration. See project map for the location of the stream channel stabilization measures.

The streambanks on county ditch No. 8 are eroding in some areas mostly due to poor soil conditions (SP-SM). Studies show that to completely protect the banks from erosion would require costly installations involving channel lining or grade stabilization structures that will go well beyond the economic feasibility of this project. A more intensive maintenance program will maintain the streambanks in its present condition or even improve the streambanks. The maintenance program would require some diking and installation of surface inlets to eliminate the damages of the banks from overflows. An improved vegetative program will also be needed and maintained.

#### County Ditch No. 19 Subwatershed

The northwest area of Canby and the agricultural area north of Canby have considerable flood damage. The local people requested improvements for these areas. The legal ditch, county ditch No. 19, is located in the lower part of this watershed. It commences at its junction with Lazarus Creek and terminates in the NW $\frac{1}{4}$  of section 4, T. 114 N., R. 45 W. See the water development project map.

The local people also had located a possible floodwater-retarding structure site R-4 in the headwaters above Canby. This area was studied and the final site was located about 1 mile upstream from Canby in the SE $\frac{1}{4}$  of section 5, T. 114 N., R. 45 W. See the project map. Studies determined that a structure at this location can control the Q<sub>100</sub> frequency flood in the present channel northwest of Canby and the Q<sub>5</sub> in the area below the city without flooding. With this kind of control, no further improvements of the existing channel and bridges were planned except for one road culvert in the northeast corner of section 4, T. 114 N., R. 45 W., on the north side of Canby. The present culvert cannot carry the future 100-year frequency flood without inducing flooding so a new culvert was planned.



The area was investigated for possible channel improvement. It would be difficult and costly to improve the present channel because it is adjacent to a black-top road on one side and a utility line along the other side. There also are farmsteads and a bowling alley close to the channel. Bridges would need to be rebuilt and channel grade stabilization structures would be necessary. A possibility considered but not investigated was to construct a new channel on the half-mile line in sections 33 and 28 to Lazarus Creek.

County ditch No. 19 will continue to need a maintenance program.

The R-4A structure was studied with a single and two stage principal spillway at two different dam axes. The single stage proved to be the most economical to control the floods. The two different dam axes were studied for the most economical site as well as for the best location for the emergency spillway. The upper site was chosen.

No engineering investigations were conducted in the area of the newly constructed storm sewer in Canby. The storm sewer has inlets at the C & N.W. Railroad tracks as well as in the alley between Poplar and Walnut Streets and outlets into county ditch No. 19 at the southeast corner, section 33, T. 115 N., R. 45 W. For location of the storm sewer, see Water Development Project Map (Figure 1).

#### Miller Group Subwatershed

The Miller Group is experiencing flooding and drainage problems and requested assistance in solving them. However, studies indicated that a feasible plan did not exist.

See Water Development Project Map for location in watershed.

The outlet for the Miller Group changed from Canby Creek to the Lac qui Parle River to the east with the improvement of St. Leo Road. An outlet developed in the St. Leo Road Ditch. The channel and bridges for this outlet are not adequate and there is some erosion in the channel along the east-west road. A possibility is to construct a grassed floodway with tile from the center of section 11 north to the junction of Canby Creek (near the north quarter corner of section 2) all in T. 114 N., R. 45 W. The spoil bank would be so constructed on the west side of the floodways to prevent the 100 year flood from flooding the area to the east. The present outlet would adequately carry the floodwater east of the grassed floodways.

The grassed floodway approach was investigated because the soils are glacial laid lake materials such as SM-SP with layers of CL.

However, this possibility is not economically feasible. With the additional flows added to county ditch No. 8, extensive streambank protection measures would be needed.

Several alternatives were studied to provide an outlet for the Miller Group into the Lac qui Parle River. The cost of providing an outlet along the present channel proved too costly. The shorter routes located upstream from the present channel have inadequate outlets. The Lac qui Parle River will overflow into the Miller Group area based on limited study of its flows.

The local people expressed interest in having a single-purpose floodwater-retarding structure R-5 in this subwatershed. Two sites were reviewed in the field during the Preliminary Investigation. One site was in the SW corner of section 10 and the other in the NE $\frac{1}{4}$  of section 16, both in T. 114 N., R. 45 W. The lower site was eliminated because of insufficient storage and it would flood against U.S. Highway No. 75. Therefore, the upper site in section 16 was studied.

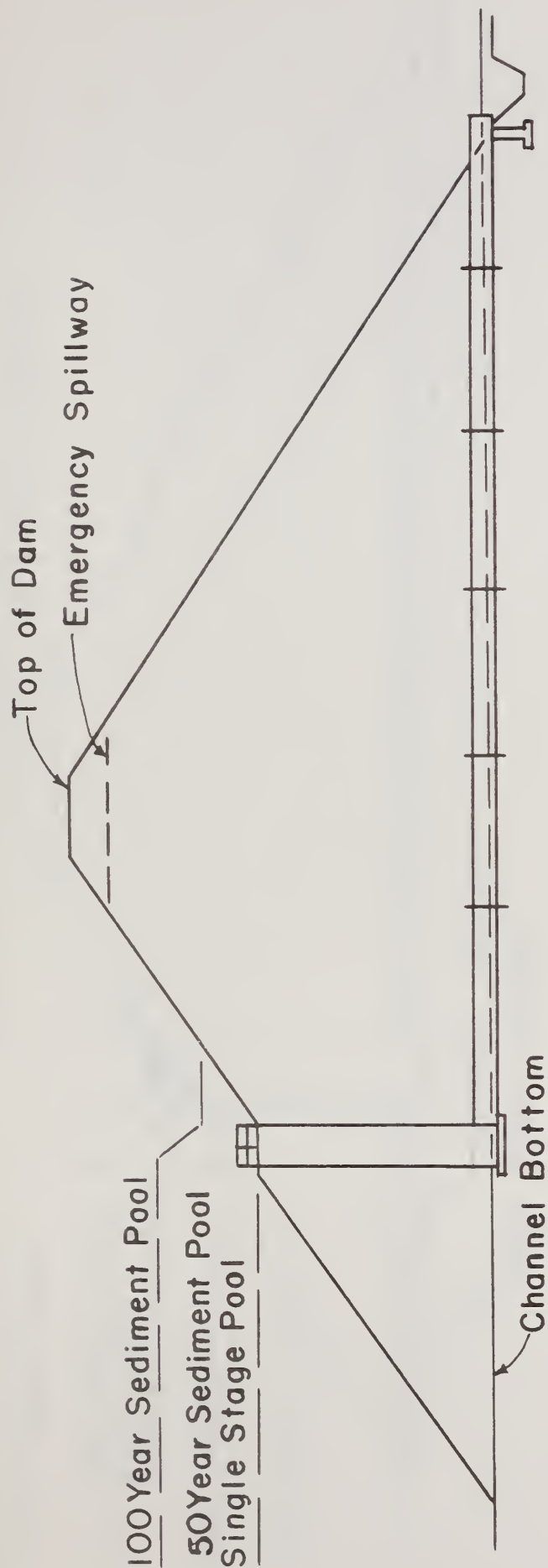
The topography of this structure site does not lend itself to an economical earth embankment because of the long dam required to obtain the height necessary for adequate storage. Soil materials, however, are very good for the foundation and embankment. Since the structure site is immediately above a U.S. Highway, it must be designed as a class "B" structure.

This structure would have been located approximately 1.5 miles above the benefited area. When the flow was routed downstream, little reduction was realized in the size of proposed floodway compared to design without the structure. The economical evaluation on structure R-5 showed incremental B:C ratio of less than 0.5 to 1 and further studies were discontinued.

Since the project will not reduce floodwater damage nor provide improved drainage outlets, the decision was to withdraw the Miller Group from the Canby Creek Watershed.

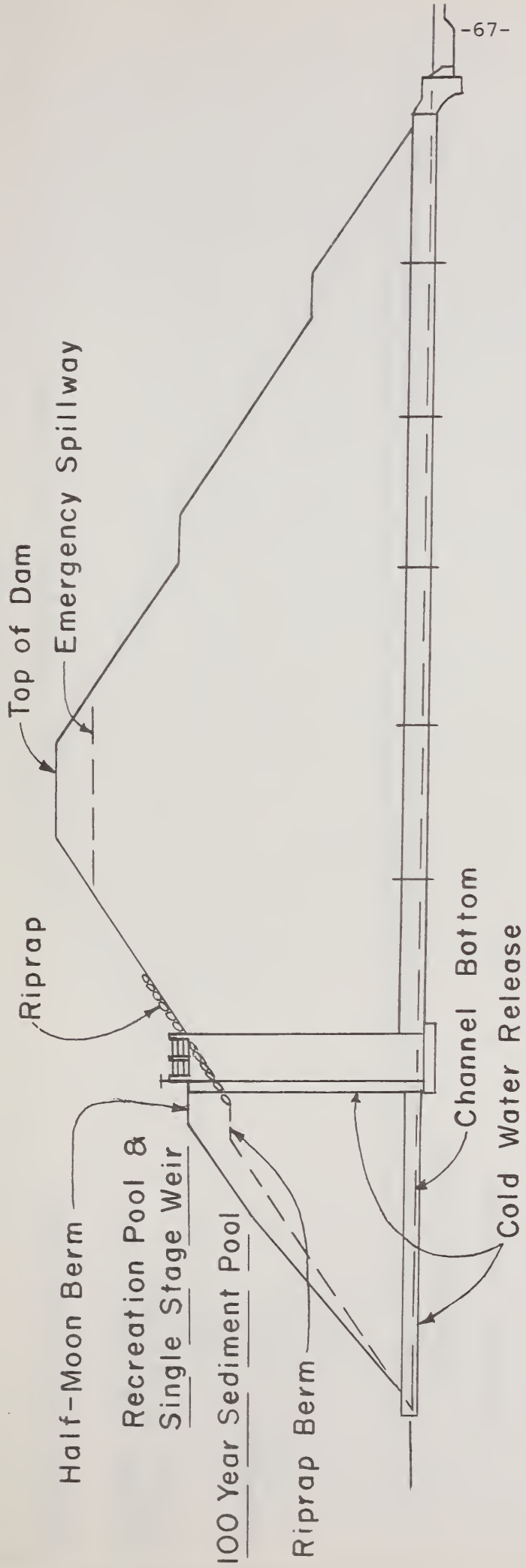






# TYPICAL FLOODWATER RETARDING STRUCTURE SECTION ON CENTERLINE

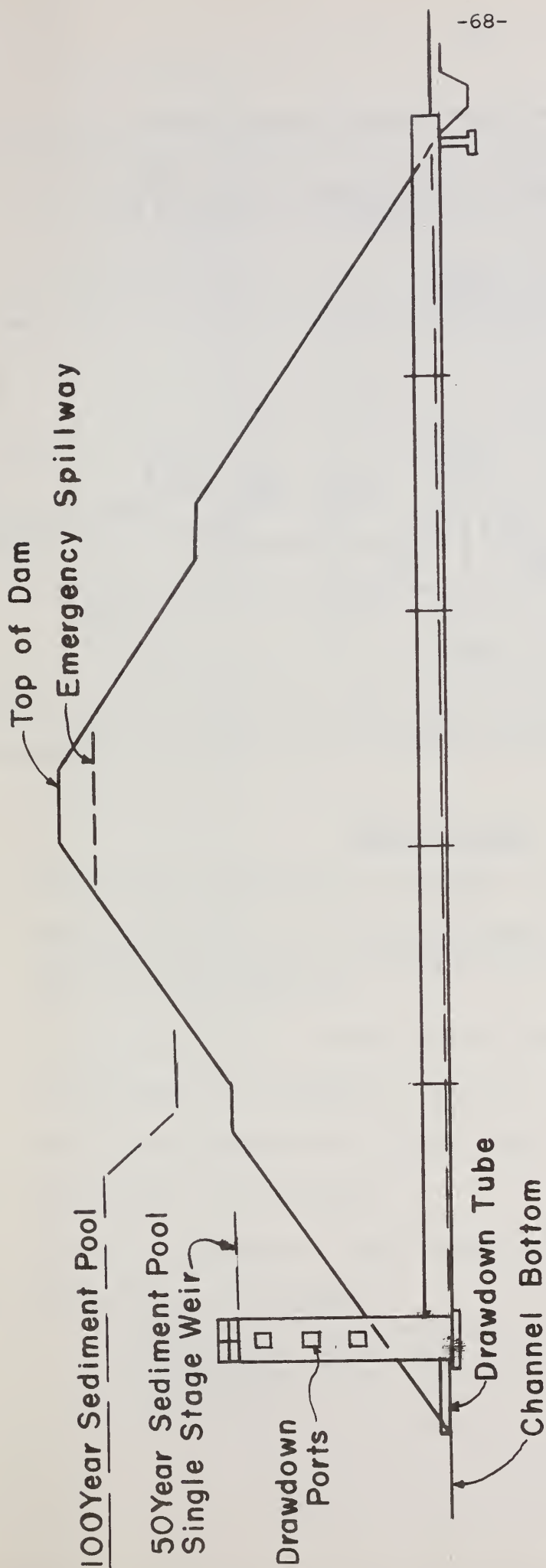




# TYPICAL MULTIPLE-PURPOSE STRUCTURE SECTION ON CENTERLINE

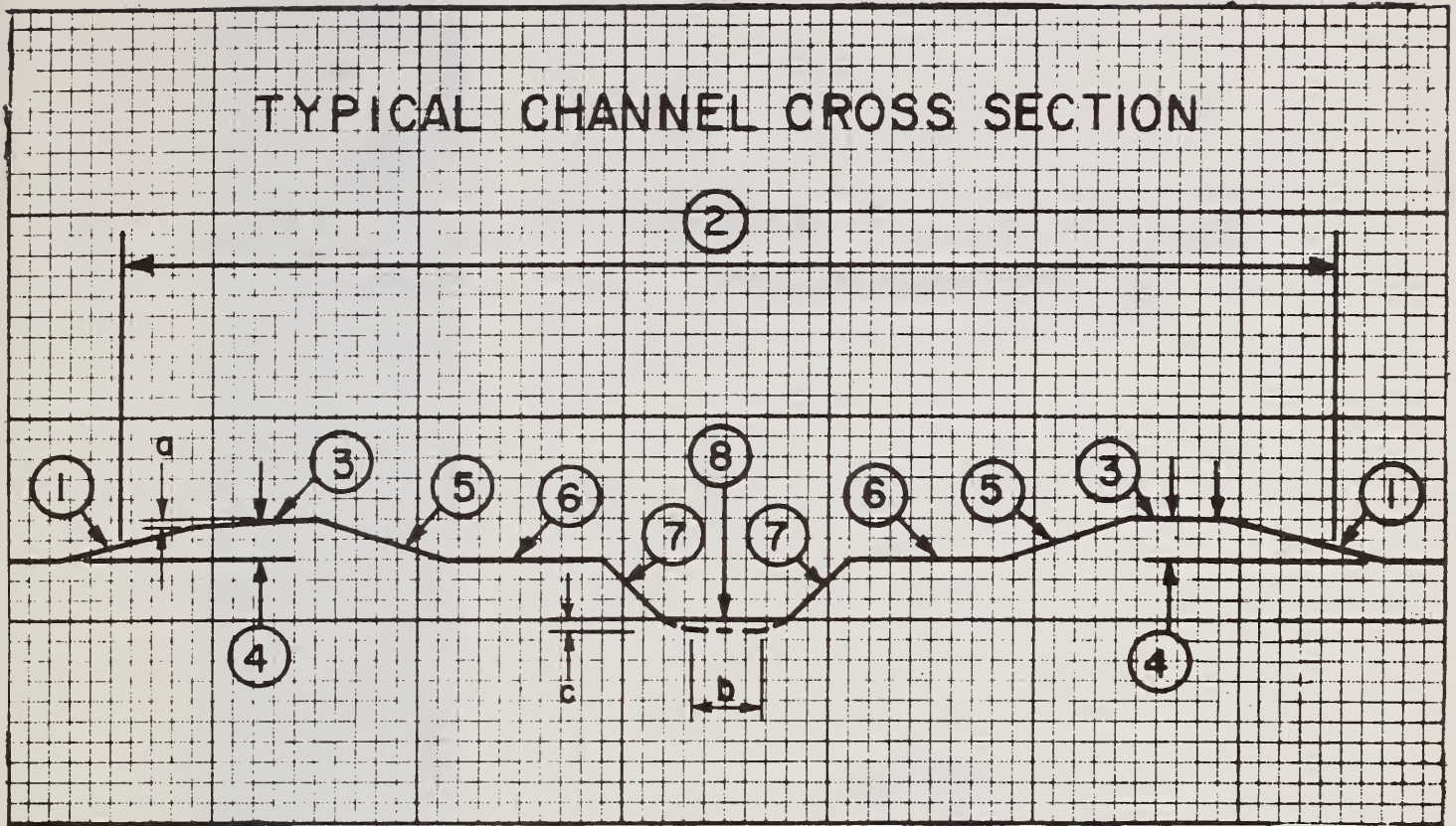






TYPICAL FLOODWATER RETARDING STRUCTURE WITH DRY POOL  
SECTION ON CENTERLINE





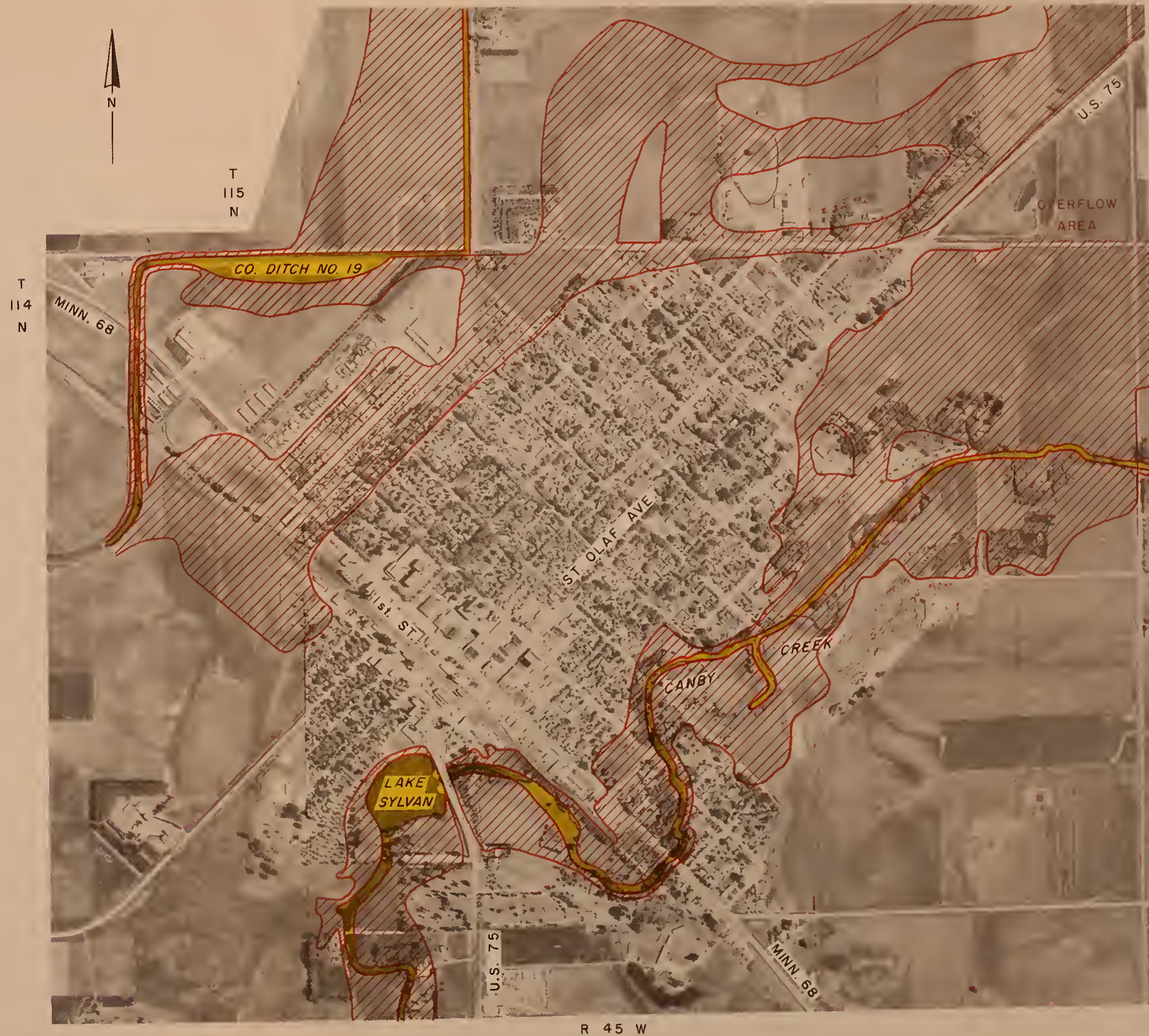
### SPECIFICATIONS

1. Side slope of spoilbank, (landside), 4:1 minimum.
2. Minimum width of right-of-way includes channel, berms and leveled spoilbank to a point 20' landward from the junction of the 3:1 SS and top of the spoilbank.
3. Top of spoilbank 10' minimum section with slope landward.  $a = 6''$
4. Maximum depth of spoilbank on main 4'.
5. Side slope of spoilbank (channel side) 3:1 minimum.
6. Berm width - 15' (minimum).
7. Side slope of channel, Canby Creek 2:1.
8. Bottom width - 4' minimum  
Bottom  $\leq 25'$  bottom is flat  
Bottom  $= 25' - 40'$ .  $b = 10' - 19'$ ,  $c = 1'$   
Bottom  $\geq 40'$ ,  $b = 20'$ ,  $c = 1'$











## URBAN FLOOD PLAIN CANBY, MINNESOTA

### LEGEND

-  100 YEAR FLOOD  
WITHOUT PROJECT
-  100 YEAR FLOOD  
WITH PROJECT

SCALE 1/11,000

SCALE 1000 0 1000 FEET

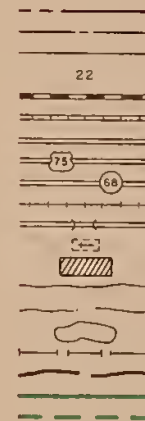
APPROXIMATE





## LEGEND

STATE LINE  
 COUNTY LINE  
 SECTION LINE  
 SECTION NUMBER  
 PAVED ROAD  
 GRAVEL ROAD  
 DIRT ROAD  
 US NUMBERED HIGHWAY  
 STATE NUMBERED HIGHWAY  
 RAILROAD  
 BRIDGE  
 CEMETERY  
 TOWN  
 PERENNIAL STREAM  
 INTERMITTENT STREAM  
 LAKE  
 PIPELINE  
 WATERSHED BOUNDARY  
 DITCH  
 STORM SEWER



WATER DEVELOPMENT PROJECT MAP  
 CANBY CREEK WATERSHED  
 LAC QUI PARLE, LINCOLN, AND  
 YELLOW MEDICINE COUNTIES, MINNESOTA

SCALE 1" = 1 MILE  
 SCALE 1/76,000  
 0 1 2 3 MILES







PUBLIC RECREATION DEVELOPMENT  
STRUCTURE R-1  
CANBY CREEK WATERSHED  
LAC QUI PARLE, LINCOLN, AND  
YELLOW MEDICINE COUNTIES, MINNESOTA

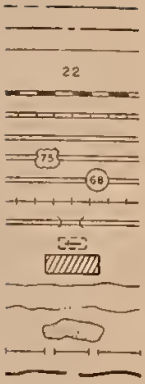
SCALE 1/9,600  
SCALE 400 0 400 800 1200 1600 FEET





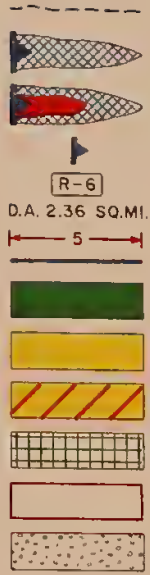


STATE LINE  
COUNTY LINE  
SECTION LINE  
SECTION NUMBER  
PAVED ROAD  
GRAVEL ROAD  
DIRT ROAD  
US NUMBERED HIGHWAY  
STATE NUMBERED HIGHWAY  
RAILROAD  
BRIDGE  
CEMETERY  
TOWN  
PERENNIAL STREAM  
INTERMITTENT STREAM  
LAKE  
PIPELINE  
WATERSHED BOUNDARY



LEGEND

SUB WATERSHED BOUNDARY  
FLOODWATER RETARDING STRUCTURE  
MULTIPLE PURPOSE STRUCTURE  
GRADE STABILIZATION STRUCTURE  
STRUCTURE NUMBER  
DRAINAGE AREA IN SQUARE MILES  
EVALUATION REACH  
STREAM CHANNEL STABILIZATION  
DRAINAGE AREA CONTROLLED BY STRUCTURE  
AREA BENEFITED  
COMMON FLOOD PLAIN BENEFITED  
RECREATION DEVELOPMENT AREA  
STATE WILDLIFE MANAGEMENT AREA  
PORTION OF NATURAL CHANNEL MAINTENANCE AREA WHICH PROVIDES FOR GRAVEL MINERAL RIGHTS



PROJECT MAP  
CANBY CREEK WATERSHED  
LAC QUI PARLE, LINCOLN, AND  
YELLOW MEDICINE COUNTIES, MINNESOTA







